

Appendix G

Emissions Analysis Methodology and Results

**Medium-Heavy Duty Diesel Trucks, Heavy-Heavy Duty Diesel Trucks,
and Regulated Bus Categories**

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List of Acronyms

| | |
|-----------------|--|
| AADTT | Annual Average Daily Truck Traffic |
| ARB | Air Resources Board |
| BACT | Best Available Control Technology |
| BEA | Bureau of Economic Analysis |
| BLS | Bureau of Labor Statistics |
| BOE | Board of Equalization |
| BTS | Bureau of Transportation Statistics |
| Caltrans | California Department of Transportation |
| CBA | California Bus Association |
| CPUC | California Public Utilities Commission |
| CY | Calendar Year |
| DMV | Department of Motor Vehicles |
| DOF | Department of Finance |
| DPF | Diesel Particulate Filter |
| EDA | Equipment Data Associates |
| FHWA | Federal Highway Administration |
| GDP | Gross Domestic Product |
| GVWR | Gross Vehicle Weight Rating |
| HDT | Heavy-Duty Truck |
| HHDDT | Heavy Heavy-Duty Diesel Trucks |
| IFTA | International Fuel Tax Agreement |
| IRP | International Registration Plan |
| LP | License plate |
| MHDDT | Medium Heavy-Duty Diesel Trucks |
| MVSTAFF | California Motor Vehicle Stock, Travel and Fuel Forecast |
| MY | Model Year |
| NAAQS | National Ambient Air Quality Standards |
| NOOS | Neighboring out-of-state |
| NO _x | Nitrogen Oxides |
| NNOOS | Non-neighboring out-of-state |
| OD | Origin-Destination |
| OOS | Out-of-state |
| PM | Particulate Matter |
| POAK | Port of Oakland |
| POLA | Ports of Los Angeles and Long Beach |
| PTO | Power Take Off |
| SCAG | Southern California Association of Governments |
| SIP | State Implementation Plan |
| TEU | Twenty-foot equivalent unit |
| UCC | Uniform Commercial Code |
| USDOE | United States Department of Energy |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| VIUS | Vehicle Inventory and Use Survey |
| VMT | Vehicle Miles Traveled |

A. Introduction

Commercial heavy-duty diesel trucks and buses (commercial diesel buses and trucks exceeding 14,000 lbs gross vehicle weight rating (GVWR)) are currently the single largest source of nitrogen oxide (NO_x) emissions in California, accounting for 30 percent of statewide NO_x emissions (ARB, 2008). These same trucks and buses are also the largest source of diesel particulate matter (diesel PM) in California, representing about 40 percent of statewide diesel PM emissions.

In December 2008, the Air Resources Board (ARB or Board) adopted the Statewide Truck and Bus Rule (regulation). That regulation was designed to achieve emissions reductions by requiring truck and bus fleet owners to modernize their fleets and install exhaust retrofits. As part of that regulatory development, staff developed a statewide emissions analysis that quantified emissions from different types of trucks and buses separated by registration type, body type and/or vocation as well as mileage thresholds. The assumptions used in development of that emissions analysis were published in Appendix G of the technical support document (TSD) for the 2008 rulemaking, and the results of the inventory were published in an on-line database (ARB, 2008).

In December 2008, the National Bureau of Economic Research declared that the United States had entered an economic recession. That recession turned out to be the most severe in the United States since the Great Depression. In December 2009, staff reported its statewide estimate of the impact of the economic recession on truck and bus emissions. Results suggested that emissions in 2009 across all trucks and buses operating in California were approximately 20 percent lower than estimates provided in the 2008 Rule staff report (ARB, 2009). As a result of the recession, the Board directed staff to develop regulatory amendments to the Rule that provide economic relief while ensuring air quality goals would still be attained.

The emissions inventory developed to support the proposed regulatory amendments builds upon the 2008 and 2009 work. We revised the inventory methodology to improve the quality and accuracy of emissions estimates. We revised growth rates and forecasted vehicle age distributions to reflect the impact of the economic recession both today and in the future. We developed a new procedure for allocating statewide emissions to each air basin in California so the impact of the Rule could be evaluated regionally. Finally, we assessed the impact of the proposed regulatory amendments on emissions from Trucks and Buses on a statewide and regional basis. This appendix provides the fundamental analysis behind updates to the emissions analysis, regional emissions estimates, the impact of the economy on emissions, and the emissions impact of new regulatory amendments.

B. Methodology

Emissions are calculated as the product of a population of vehicles, the number of miles each vehicle travels, and emission rates per mile. Beneath this simple equation lies a series of data and assumptions about the population, miles traveled, and emission rates per vehicle model year in a given calendar year, growth and attrition estimates, deterioration, and other factors that affect emissions estimates, all of which were discussed in the 2008 Rulemaking. We applied the concept separately for each analysis category of trucks that shares similar travel, service, size, age or other characteristics.

$$\sum_{MY, C} (POP_{MY, C} \times AC_{MY, C} \times ER_{MY, C}) = EMS_{CY}, \quad \text{Equation 1}$$

where: POP_{MY, C} is the population of trucks for model year MY within each analysis category C for a given calendar year;
AC_{MY, C} is the accrual rate (miles traveled per year) per truck by model year MY and analysis category C in a given calendar year;
ER_{MY, C} is the calculated emission rate, in grams pollutant per mile driven, assuming statewide speed travel distributions in EMFAC2007 and fleet specific cumulative mileage accrual over the life of the truck, by model year MY and analysis category C;
EMS_{CY} is the emissions calculated in tons per day for a given calendar year.

The basic calculation methodology is unchanged from that described in Appendix G of the Rule Initial Statement of Reasons published in ARB (2008). Emissions analysis updates described in this document relate to changes in inputs to the methodology.

The emissions analysis methodology published in 2008 involved applying annual average growth rates that are independent of the economic cycle. In 2009 staff developed a scaling model that was designed to assess the impact of multiple potential economic forecast scenarios on emissions (ARB, 2009). For this rulemaking, staff are using an emissions forecast that reflects the average of a fast recovery and slow recovery bounding scenario. This emissions forecast scenario is input directly to the emissions model for the analysis described in this document.

C. Statewide Emissions Analysis Updates

1) Construction Trucks

In the emissions analysis presented to the Board in December, 2008, ARB staff categorized the medium heavy-duty diesel trucks (MHDDT) and heavy heavy-duty diesel trucks (HHDDT)¹ into different fleet categories that differentiated trucks and buses by registration type (in-state vs. interstate), body type (tractor, single-unit, etc.),

¹ Heavy-duty diesel trucks include MHDDT with a GVWR above 14,000 lbs and up to 33,000 lbs, and HHDDT with GVWR above 33,000 lbs.

and vocation (agricultural, construction, drayage, etc.). Over the past year staff listened to stakeholder comments and evaluated the impact of the recession on the construction sector. Our analysis suggested that trucks involved in construction have been impacted more severely by the recession than other trucking sectors. In order to reflect this finding, staff separated trucks owned by construction firms from other trucking categories in the inventory, and then developed an alternate economic forecast reflecting the economic downturn on construction trucking.

Like other vocational trucking categories, trucks owned by construction firms cannot be easily identified through the California Department of Motor Vehicles (DMV) registration database. To identify a population of construction trucks, staff analyzed data in the Vehicle Inventory and Use Survey (VIUS), (VIUS, 2002). Construction trucks were identified in the survey by selecting “construction” as the industry in which the vehicle was most used. Based on the survey, staff estimated the fractions of trucks in the construction industry relative to the population in the inventory fleet category and the results are shown in Table 1.

Table 1. Percentage of Construction Trucks by Inventory Category

| | Percent of Construction Trucks in Each Category |
|--------------------------|--|
| MHDDT instate | 21 |
| HHDDT tractor | 20 |
| HHDDT single-unit | 40 |
| HHDDT CAIRP ² | 6 |

Next, staff evaluated the age distribution of construction trucks in VIUS and compared that to all trucks in VIUS. Results suggested that construction trucks have roughly the same average age profile as other trucking categories, and as a result staff decided to assume that construction trucks by body type have the same age distribution as non-construction trucks of the same body type and registration status. Table 2 compares the average age of construction trucks against non-construction trucks by inventory category.

Table 2. Construction vs. Non-Construction Truck Average Age (VIUS, 2002)³

| | Construction | General |
|---------------------------|---------------------|----------------|
| Tractor | 8.0 | 7.4 |
| Single Unit (non-tractor) | 7.6 | 7.2 |

² CAIRP: California registered International Registration Plan (IRP) trucks

³ VIUS grouped all age 16 and older into one category and only trucks age 15 or newer in VIUS were included in the analysis.

Staff assumed that all in-state registered tractors and single-unit construction trucks followed the in-state single unit accrual schedule as documented (ARB, 2008).

The emission factors remain unchanged; as a result HHDDT single-unit emission rates are used for HHDDT construction single-unit trucks, HHDDT tractor emission rates for HHDDT construction tractors, HHDDT IRP truck emission rates for HHDDT construction IRP trucks, and MHDDT emission rates for MHDDT construction trucks.

To estimate the impact of the recession on construction activity in California, staff reviewed a variety of economic indicators. Surrogates for construction emissions such as employment, gross domestic product, building permits, value of equipment financed, and fuel consumption indicate that construction activity decreased between 30 percent and 80 percent in California between 2006 and 2009, as shown in Table 3.

Table 3. Impact of Recession on Economic Metrics

| Data Type | Change Relative to Peak | Data Source |
|--|--------------------------------|---|
| CA Construction Employment (2006-2009) | -30% | US Bureau of Labor Statistics (BLS, 2010) |
| CA Construction GDP (2005-2008) | -30% | US Bureau of Economic Analysis; (BEA, 2009) |
| CA Construction Taxable Fuel Refunds (2006-2008) | -40% | CA Board of Equalization; (BOE, 2008) |
| CA Construction Valuation (2005-2009) | -65% | CA Dept of Finance; (DOF, 2010) |
| CA New Building Permits (2004-2009) | -80% | CA Dept of Finance; (DOF, 2010) |
| CA New Equipment Sales Financed (2005-2009) | -80% | Equipment Data Associates; (EDA, 2010) |

Based on above reviews, staff estimated a 50 percent reduction in activity from 2006 to 2009. Staff generated an estimation of average recovery using bounding fast and slow recovery scenarios to represent both vehicle miles traveled (VMT) growth assumptions, as shown in Figure 1, and vehicle sales in the construction sector, as shown in Figure 2. Construction vehicle sales trends were estimated using the relationship between vehicle sales and economic trends documented in the staff report for the 2008 Truck and Bus rulemaking (ARB, 2008).

Figure 1. Construction Vehicle Miles Travelled (VMT) Growth Assumption

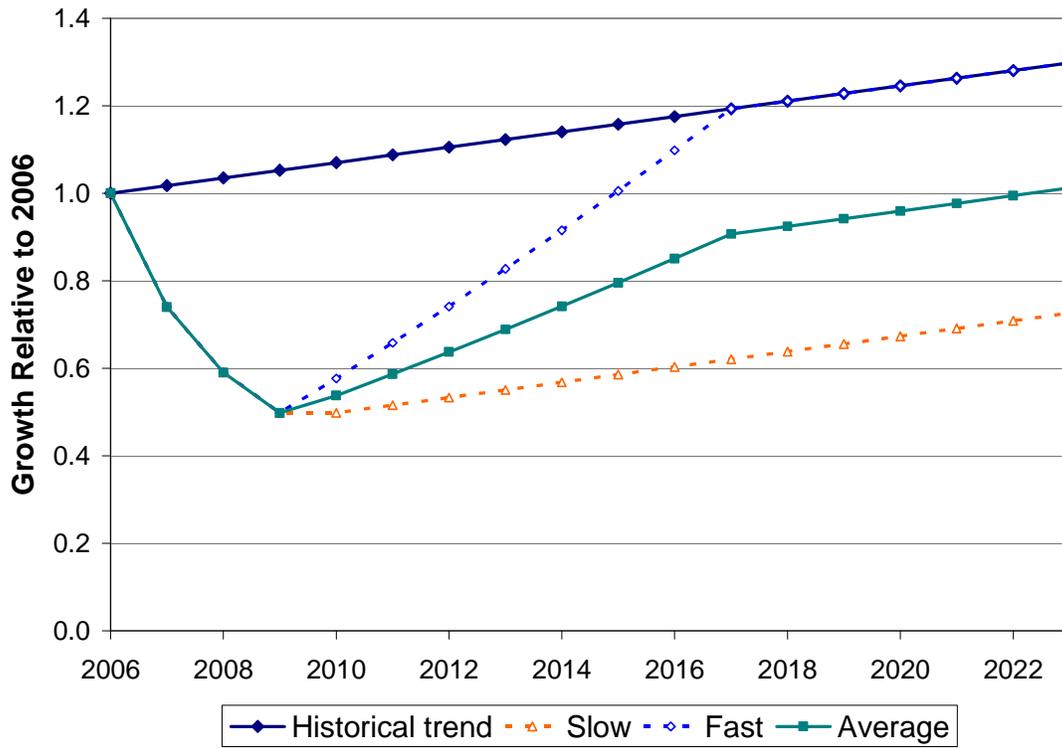
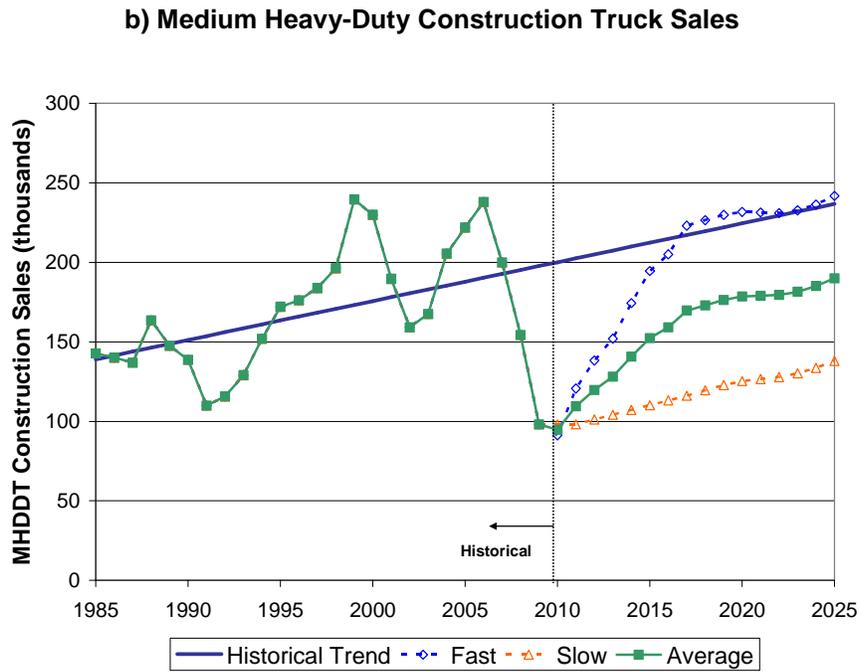
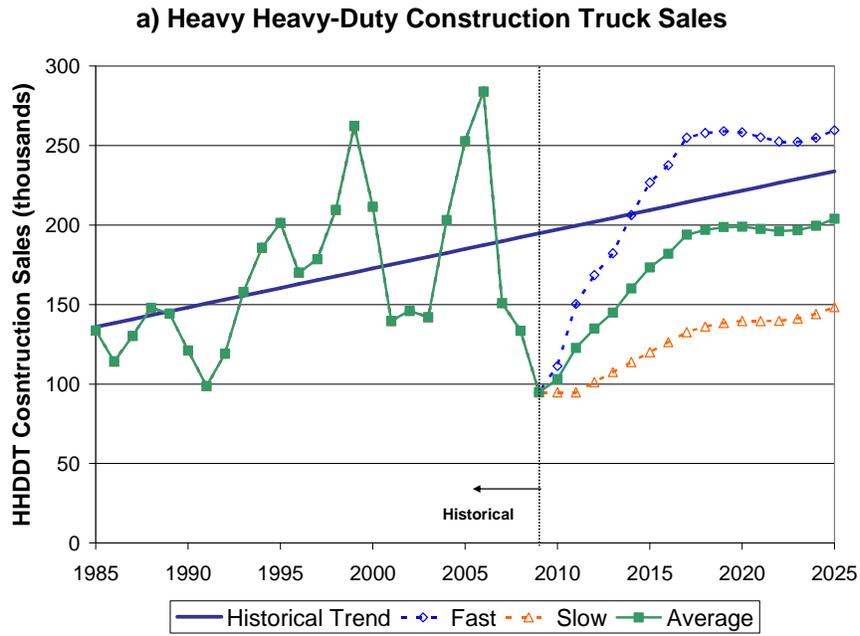


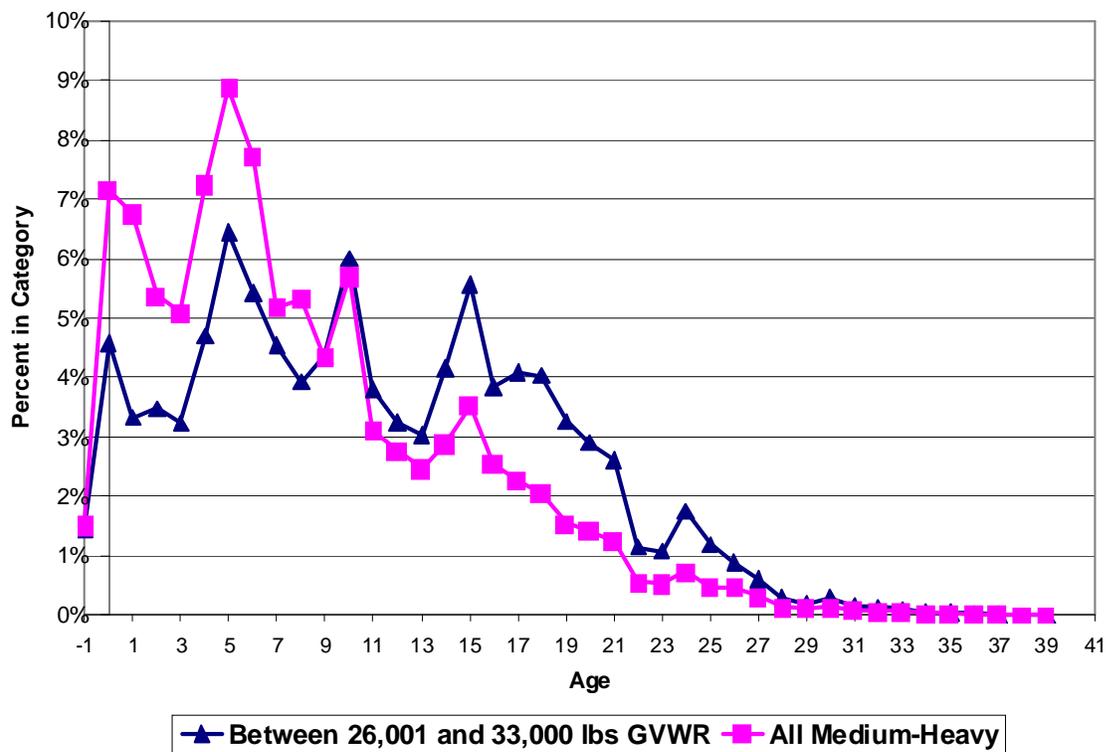
Figure 2. Construction Truck Sales Trend and Estimated Recovery



2) Medium Heavy-Duty Diesel Truck Population Split

Diesel fueled trucks with a GVWR between 14,000 and 33,000 lbs GVWR are considered to be MHDDT. The proposed amended regulation would exempt vehicles with a GVWR less than 26,000 lbs from meeting PM filter requirements. To estimate the population of vehicles that are above 26,000 lbs within the MHDDT category staff analyzed the GVWR code of MHDDT in the DMV registration data (DMV, 2005). Results suggest that about 30 percent of the MHDDTs statewide are above 26,000 lbs and they have different age distribution than the overall medium heavy-duty diesel trucks as shown in Figure 3.

Figure 3. Medium Heavy-Duty Diesel Truck Age Distributions



The average age of diesel trucks with GVWR between 26,000 and 33,000 lbs is about 11 years old while the overall medium heavy-duty diesel is about 8 years old. To reflect the differences in age distribution and population fraction, staff assumed that 30 percent of MHDDTs between age 9 and 13, 58 percent of the older than 13 years and 20 percent of vehicles newer than nine years old are MHDDT above 26,000 lbs. This assumption is applied to MHDDT instate and interstate trucks.

3) Impact of Recession and Growth by Category

As described in ARB (2009), the recession has had a major impact on the trucking industry. In order to develop the updated emissions analysis, staff revisited fuel and economic truck activity indicators to estimate the impact of the recession on truck and bus operations in California. Using the same methodology as described in ARB (2009) staff developed an estimate for an average recovery forecast based on fast and slow bounding recovery scenarios.

Staff's previous analysis identified a relationship between overall economic trends and truck sales. The impact of this relationship is that as the economy has deteriorated as a result of the recession, national new truck sales have decreased and fewer new vehicles are registered in California (ARB, 2009). Because of this relationship, staff has developed both forecasts for the impact of the reduced total vehicle activity caused by the recession on emissions by truck category, and forecasts for the impact of reduced vehicle sales on emissions by truck category. Detailed assumptions by category are presented in Section F.

4) Motorcoach/Buses

In the December 2008 Board Hearing, the Board adopted specific regulatory provisions for motorcoaches. In order to reflect these regulatory provisions, staff consulted with the California Bus Association (CBA) to obtain information to assist in estimating the population, mileage accrual rates, and other assumptions for the motorcoach inventory category. The CBA provided population estimates from the California Public Utility Commission (CPUC, 2009), and results of a survey (CBA, 2010) that could be used to assess mileage accrual. The age distribution was assessed by matching registered motorcoach companies against the buses those firms registered in the DMV database. Staff subtracted the motorcoach population by age from the other bus category, and assumed a 1.75 percent growth rate per year in the absence of the recession. Staff used HHDDT emission rates because motorcoaches are rated in excess of 33,000 lbs GVWR, and emission rates for the other bus category from which motorcoaches were extracted are based on a weighted average of heavier and lighter buses.

To estimate the impact of the recession, staff used CBA provided population estimates in 2000 (3376), 2008 (3589), and 2009 (3125). Age distributions were forecasted by assuming heavy heavy-duty vehicle sales forecasts developed using the fast and slow recovery bounding scenarios. Table 4 provides assumed motorcoach populations and VMT, while Figure 4 shows the assumed accrual schedule.

Table 4. Motorcoach Population and VMT

| Year | Motor Coach Population | | VMT (million miles per year) | |
|------|------------------------|----------------|------------------------------|----------------|
| | No Recession | With Recession | No Recession | With Recession |
| 2000 | 3320 | 3320 | 147 | 147 |
| 2005 | 3670 | 3670 | 160 | 160 |
| 2007 | 3760 | 3451 | 166 | 153 |
| 2008 | 3914 | 3294 | 169 | 143 |
| 2009 | 4042 | 3125 | 172 | 133 |
| 2010 | 4113 | 3240 | 175 | 137 |
| 2014 | 4374 | 3775 | 187 | 158 |
| 2020 | 4834 | 4375 | 208 | 183 |

Figure 4. Motorcoach Mileage Accrual



5) Out-of-State Vehicle Miles Traveled

The 2008 inventory analysis assumed a set amount of VMT by out-of-state (OOS) trucks in California in 2005, based on information from the International Fuel Tax Agreement (IFTA) program provided by email from the California State Board of Equalization (BOE, 2010a). After the 2008 inventory was developed BOE provided 2007 calendar year estimated out-of-state truck VMT and fuel usage in California. This number was substantially lower than what had been provided in 2005. In 2010, staff received 2008 and 2009 estimated out-of-state truck VMT and fuel usage in California. Overall, data representing California registered trucks in the IFTA program appears plausible, with a 20 percent increase between 2005 and 2007, and then a 20 percent decrease due to the recession from 2007 to 2009. Out-of-state VMT data shown in Table 6 are not consistent between 2005 and 2007-2009. For example, the 2005 data provided by BOE are much higher than any of the 2007-2009 data, and the 2008 data are higher than 2007 data. These trends are not consistent with either economic surrogates or overall on-road fuel trends. Because of these anomalies in the IFTA data, staff decided to adjust the IFTA numbers for out-of-state trucks to reflect our best estimate of what out-of-state truck VMT in California should be given the totality of available data. To adjust the data, staff calculated the average annual truck VMT between 2007 and 2009 for OOS and for CA registered IFTA respectively, and then back-casted 2005 out-of-state IFTA miles based on the ratio of the two averages and 2005 CA registered IFTA truck miles. Staff then applied the impact of the recession as measured by the BOE data for on-road fuel trends. The BOE IFTA data, as well as staff assumptions based on the data are shown in Table 5.

Table 5. Reported and Estimate Interstate VMT (million miles/year) in California: 2005-2009

| Year | CA Registered IFTA Truck Miles in CA | Reported OOS Truck Miles in CA | Modeled OOS Truck Miles in CA no recession | Modeled OOS Truck Miles in CA with recession |
|------|--------------------------------------|--------------------------------|--|--|
| 2005 | 2,189 | 4,398 | 3,144 | 3,144 |
| 2007 | 2,660 | 2,943 | 3,419 | 3,397 |
| 2008 | 2,213 | 3,761 | 3,601 | 3,115 |
| 2009 | 2,134 | 3,358 | 3,654 | 2,843 |

6) Odometer Capping

Truck emission rates are a function of cumulative mileage on the vehicle through an emissions process called deterioration. The cumulative lifetime mileage on a vehicle can be measured using the vehicle's odometer. Previous analyses, as well as the EMFAC2007 model, assumed that odometer is a function of the year by year mileage accrual. To evaluate this assumption, staff collected truck "for-sale" records from truckpaper.com that contained odometer readings, as well as odometer records from the Goods Movement Bond Program and data in VIUS (2002). Results demonstrated that odometer is not simply a function of the year by year mileage accrual, and instead odometer readings tend to level off depending on engine design life. This concept is shown in Figure 5.

Figure 5. Schematic Representation of Difference between Current and Revised Method for Estimating Vehicle Odometer



The reason for the difference is that when a truck or vehicle is young, the average odometer is a function of some high accruing and some low accruing vehicles. As vehicles age higher mileage vehicles are scrapped more quickly than lower mileage vehicles. So, surviving older vehicles are more likely to have accrued fewer miles than average when those vehicles were younger. The net result is that odometer is a function of both accrual rates and vehicle survival rates, and observed odometer readings in practice tend to level out to a constant level for older vehicles. Staff decided to cap odometer readings at a specific value for each truck category and used capped

odometer-age relation to generate emission rates by age. The choice of the cap depends on the data sources evaluated; in this case staff decided to cap odometer levels at 800,000 for HHDDTs, and at 400,000 for MHDDTs, as shown in Table 6. Overall, the change in odometer led to less than a 5 percent change in the inventory for any calendar year.

Table 6. Odometer Cap by Inventory Category

| Inventory Category | Survival Rate Based Odometer Reading Cap Value |
|----------------------------|--|
| MHDDT Ag | 400,000 |
| MHDDT CAIRP | 400,000 |
| MHDDT instate | 400,000 |
| MHDDT OOS | 400,000 |
| HHDDT Ag | 800,000 |
| HHDDT CAIRP | 800,000 |
| HHDDT NNOOS | 800,000 |
| HHDDT NOOS | 800,000 |
| HHDDT other port | 800,000 |
| HHDDT POAK | 800,000 |
| HHDDT POLA | 800,000 |
| HHDDT single | No change from ARB (2008) |
| HHDDT tractor | 800,000 |
| MHDDT utility | No change from ARB (2008) |
| HHDDT utility | No change from ARB (2008) |
| MHDDT instate construction | 400,000 |
| HHDDT single construction | No change from ARB (2008) |
| HHDDT tractor construction | 800,000 |
| HHDDT CAIRP construction | 800,000 |

D. 2008 Truck Field Data Collection

1) Study Design and Data Collection Locations

In 2008 ARB staff implemented a large-scale field data collection effort. The primary objective of this effort was to obtain information to improve regional allocation estimates of heavy-duty truck (HDT) activity. The data collection effort consisted of two components: license plate (LP) surveys and origin-destination (OD) surveys. License plate surveys consisted of time-stamped digital photographs at each location, and provided the mixture of trucks by registration type at 15 weigh stations and 15 roadside locations⁴. OD surveys were collected by intercepting and talking with truck drivers to obtain information on the truck and on the current trip. OD surveys provided trip information which helped to allocate the trip VMT into geographic areas, and were

⁴ The license plate data collection effort obtained data from 16 weigh stations and 30 roadside locations. However, given the time required to process data, staff prioritized the list of locations to be processed so that most weigh stations and major representative roadside locations in the South Coast, the San Joaquin Valley and the San Francisco Bay Area are included in the analysis.

collected at 18 weigh stations and 3 roadside locations. Attachment A provides the OD survey instrument. A total of 54,570 license plates and 6,215 OD surveys were collected and processed for the regional allocation analysis. Most of the data were collected during the daytime and in the middle of the week.

The survey was designed to capture both inter-regional and local trips. Two types of survey sites were considered: locations on major freeways at the border of an air basin and locations inside a particular region or air basin. Locations near state borders were omitted from this study to focus on intra-state truck traffic. Interstate truck traffic data collected by UC Davis (Lutsey, 2008) were used to inform and supplement data collected through the ARB field data collection; that collection effort was focused on roadways near California's border with Mexico, Nevada, Arizona, and Oregon.

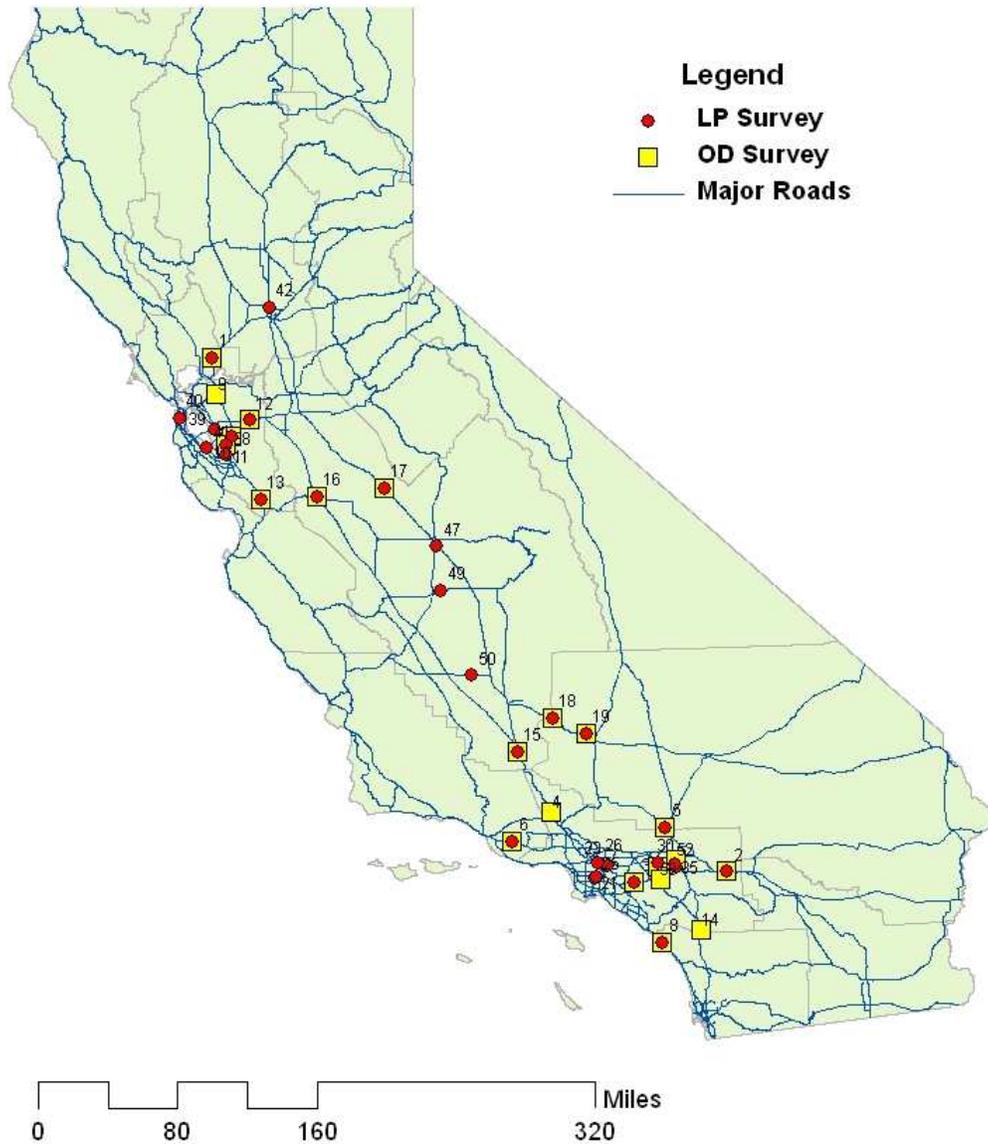
Data collection covered all major portions of the California state highway system, but a higher concentration of data was collected in the South Coast Air Basin and San Joaquin Valley Air Basin. OD surveys were conducted primarily at weigh stations for safety purposes, and tended to be biased towards inter-regional trips because weigh stations are typically located between rather than within regions. License plate collection sites were focused on assessing the mix of different types of vehicles operating within a region, and selected locations were located across a region of interest. Table 7 and Figure 6 show survey locations.

Table 7. ARB 2008 Statewide HDT LP and OD Survey Plan

| Site ID# | Route | County | Name/Description | Direction* | Hours of work per day | Number of days per direction | |
|---------------------------------------|-----------------------------------|----------------|----------------------------|------------|-----------------------|------------------------------|----|
| | | | | | | LP | OD |
| Weigh Stations | | | | | | | |
| 1 | I-80 | Solano | Cordelia | EB/WB | 24 | 2 | 3 |
| 2 | I-10 | Riverside | Desert Hills | EB/WB | 24 | 3 | 3 |
| 3 | CA-91 | Orange | Peralta | EB/WB | 9 | 2 | 3 |
| 4 | I-5 | Los Angeles | Castaic | NB | 9 | | 3 |
| 5 | I-15 | San Bernardino | Cajon | NB/SB | 9 | 2 | 3 |
| 6 | US-101 | Ventura | Conejo | NB/SB | 9 | 2 | 3 |
| 8 | I-5 | San Diego | San Onofre | NB/SB | 9 | 2 | 3 |
| 9 | I-680 | Contra Costa | Walnut Creek | NB/SB | 9 | | 3 |
| 10 | I-680 | Alameda | Mission Grade | NB | 9 | 2 | 3 |
| 11 | I-880 | Alameda | Nimitz | NB/SB | 9 | 2 | 3 |
| 12 | I-580 | Alameda | Livermore | EB/WB | 9 | 2 | 3 |
| 13 | US-101 | Santa Clara | Gilroy | NB/SB | 9 | 2 | 3 |
| 14 | I-15 | San Diego | Rainbow | NB/SB | 9 | | 3 |
| 15 | 5 | Kern | Grapevine | SB | 9 | 2 | 3 |
| 16 | 5 | Merced | Santa Nella | NB/SB | 9 | 2 | 3 |
| 17 | 99 | Merced | Chowchilla River | NB | 9 | 2 | 3 |
| 18 | 58 | Kern | Keene | EB | 9 | 2 | 3 |
| 19 | 58 | Kern | Cache Creek | WB | 9 | 2 | 3 |
| Roadside/overpass Survey Sites | | | | | | | |
| 21 | I-710 | Los Angeles | Near Jct 105 | NB/SB | 9 | 2 | |
| 23 | I-605 | Los Angeles | Near Jct. 5 | NB/SB | 9 | 2 | |
| 25 | I-105 | Los Angeles | Near Jct 19 | EB/WB | 9 | 2 | |
| 26 | CA-60 | Los Angeles | Near Jct 710 | EB/WB | 9 | 2 | |
| 30 | I-15 | San Bernardino | South of Jct CA 60 | NB/SB | 9 | 2 | |
| 34 | CA-91 | Riverside | Near Jct 215 | EB/WB | 9 | 1 | |
| 35 | CA-60 | Riverside | Near Jct 91 | EB/WB | 9 | 1 | |
| 38 | CA-237 | Santa Clara | Near Great America Parkway | EB/WB | 9 | 1 | |
| 39 | I-880 | Alameda | Near Oakland/Jct Rte 77 | NB/SB | 9 | 1 | |
| 40 | I-280 | San Mateo | Near Daly City/Ocean Ave | NB/SB | 9 | 1 | |
| 41 | US-101 | Alameda | Near Jct 84 | NB/SB | 9 | 1 | |
| 42 | I-5 | Sacramento | at Arena Blvd | NB/SB | 9 | 1 | |
| 47 | CA-99 | Fresno | Fowler | NB/SB | 9 | 1 | |
| 49 | CA-198 | Kings | Near Jct 41 | EB/WB | 9 | 1 | |
| 50 | CA-46 | Kern | Near Jct 43 | EB/WB | 9 | 1 | |
| 51 | Etiwanda and the 60 | | | | 9 | | 1 |
| 52 | Riverside and Agua Mansa (colton) | | | | 9 | | 1 |
| 53 | 91 Fwy and the 15 Fwy (Corona) | | | | 9 | | 1 |

* Direction: NB-northbound; SB-southbound; EB-eastbound; WB-westbound

Figure 6. ARB 2008 HDT Field Study Survey Locations



Information from OD surveys and collected license plates were annotated and integrated into a database. License plate data were evaluated and cross referenced to the DMV database to obtain state of registration from all trucks, model year and GVWR from California-registered trucks.

OD surveys were generally conducted during daytime hours, with the exception of the Desert Hills weigh stations where additional surveys were collected through the night. Survey teams invited truck drivers to complete a survey while the trucks were weighed

and inspected. The surveyor inspected the truck and engine to obtain basic truck information and asked truck drivers questions verbally to help fill out the OD survey questionnaire. The questionnaire was prepared in both English and Spanish. Staff manually input OD survey data from each paper survey into a database. Using Arc GIS tools, each OD trip, including its origin, destination and route, was mapped onto the roadway system. Trips were parsed into segment by county boundary. Therefore, total trip distance and miles traveled in each air basin were generated for each trip. VMT were summarized by each truck category, survey location, trip type, and air basin.

License plate images were collected from trucks pulling through a weigh station or traveling on the roadway network at normal speeds using high performance digital cameras between February and May 2008. At each direction-specific survey location, license plate images were collected during daylight hours on weekdays for one to two days, except for the Desert Hills weigh station. At the Desert Hills weigh station, additional license plate images were also collected during night hours and on Saturday in both directions. LP pictures were manually input from each digital photograph into a database, and cross-referenced against the DMV registration database to obtain model year, body type, and other characteristics. Table 8 shows the data collection period, the number of OD records and the number of LP records collected and analyzed at each site.

Table 8. ARB 2008 Statewide HDT LP and OD Data Summary

| Site ID # | Route | Name/Description | Direction | Date | Hour | | Number of OD Survey | Number of LP Survey |
|-----------------------|--------|------------------|-----------|------------|-------|-----|---------------------|---------------------|
| | | | | | Start | End | | |
| Weigh Stations | | | | | | | | |
| 1 | I-80 | Cordelia | WB | 12/17/2007 | 14 | 23 | | 519 |
| | | | WB | 12/18/2007 | 0 | 9 | | 746 |
| | | | | 4/15/2008 | 6 | 15 | 132 | |
| | | | | 4/16/2008 | 6 | 16 | 137 | |
| | | | | 4/17/2008 | x | x | 133 | |
| 2 | I-10 | Desert Hills | EB/WB | 3/4/2008 | 2 | 16 | 71 | 691 |
| | | | | 3/5/2008 | 1 | 23 | 82 | 62 |
| | | | | 3/6/2008 | 0 | 12 | 85 | 513 |
| | | | | 3/8/2008 | 6 | 13 | 51 | |
| | | | | 3/19/2008 | 8 | 15 | 128 | 562 |
| | | | | 3/20/2008 | 7 | 12 | 130 | 361 |
| 3 | CA-91 | Peralta | EB/WB | 4/21/2008 | 6 | 14 | 59 | |
| | | | | 4/22/2008 | 6 | 14 | 64 | |
| | | | | 4/23/2008 | 6 | 14 | 56 | |
| | | | | 4/24/2008 | 6 | 13 | 69 | |
| | | | | 4/28/2008 | 6 | 15 | 62 | |
| | | | | 4/29/2008 | 6 | 14 | 76 | |
| | | | | 5/12/2008 | 8 | 11 | | 284 |
| | | | | 5/13/2008 | 7 | 15 | | 1570 |
| 4 | I-5 | Castaic | NB | 4/2/2008 | 8 | 12 | 46 | |
| | | | | 4/3/2008 | 7 | 12 | 70 | |
| | | | | 4/7/2008 | 7 | 17 | 70 | |
| | | | | 4/9/2008 | 7 | 12 | 42 | |
| | | | | 4/10/2008 | 8 | 13 | 70 | |
| 5 | I-15 | Cajon | NB/SB | 3/17/2008 | 7 | 14 | 28 | 163 |
| | | | | 3/18/2008 | 7 | 14 | 26 | 207 |
| | | | | 4/2/2008 | 7 | 14 | 33 | 249 |
| | | | | 4/3/2008 | 8 | 12 | 14 | |
| | | | | 4/7/2008 | 9 | 13 | 60 | |
| | | | | 4/28/2008 | 8 | 15 | 127 | |
| | | | | 4/29/2008 | 7 | 15 | 124 | |
| | | | | 4/30/2008 | 7 | 10 | 34 | |
| 6 | US-101 | Conejo | NB | x | 7 | 17 | 212 | |
| | | | | 4/15/2008 | 8 | 15 | 83 | |
| | | | | 4/16/2008 | 6 | 15 | 20 | 333 |
| | | | | 4/17/2008 | 7 | 14 | 52 | |
| | | | | 4/30/2008 | 6 | 10 | 54 | |
| 8 | I-5 | San Onofre | NB/SB | 4/21/2008 | 7 | 15 | 141 | 1206 |
| | | | | 4/22/2008 | 7 | 15 | 141 | |
| | | | | 4/23/2008 | 7 | 15 | 143 | 1004 |
| 9 | I-680 | Walnut Creek | NB/SB | 4/28/2008 | 7 | 13 | 80 | |
| | | | | 4/30/2008 | 7 | 9 | 36 | |
| | | | | 5/15/2008 | 6 | 15 | 53 | |
| 10 | I-680 | Mission Grade | NB | 4/28/2008 | 6 | 13 | 64 | 576 |
| | | | | 4/29/2008 | 7 | 14 | 112 | 557 |
| | | | | 4/30/2008 | x | x | 25 | |
| 11 | I-880 | Nimitz | NB | 5/19/2008 | 6 | 16 | 70 | 903 |
| | | | | 5/20/2008 | 6 | 16 | 136 | 431 |
| | | | | 5/21/2008 | 6 | 15 | 55 | |
| 12 | I-580 | Livermore | EB/WB | 5/12/2008 | 6 | 16 | 132 | 584 |
| | | | | 5/13/2008 | 6 | 16 | 134 | 134 |
| | | | | 5/14/2008 | 6 | 16 | 135 | |
| | | | | 5/22/2008 | 7 | 7 | 1 | |
| 13 | US-101 | Gilroy | SB | 5/7/2008 | 7 | 15 | 201 | 544 |
| | | | | 5/8/2008 | 9 | 13 | 200 | 411 |
| 14 | I-15 | Rainbow | NB/SB | 4/28/2008 | 7 | 16 | 144 | |
| | | | | 4/29/2008 | 7 | 15 | 138 | |
| | | | | 4/30/2008 | 7 | 15 | 133 | |
| 15 | 5 | Grapevine | SB | 4/8/2008 | 7 | 15 | 50 | 695 |
| | | | | 4/9/2008 | 7 | 15 | 71 | 384 |
| | | | | 4/10/2008 | 7 | 14 | 75 | 1014 |
| 16 | 5 | Santa Nella | NB / SB | 5/4/2008 | 7 | 9 | | 168 |
| | | | | 5/5/2008 | 7 | 7 | 201 | 199 |
| | | | | 5/6/2008 | 6 | 7 | 161 | 199 |

(continued)

| Site ID # | Route | Name/Description | Direction | Date | | Hour | | Number of OD Survey | Number of LP Survey |
|---------------------------------------|-----------------------------------|----------------------------|-----------|-----------|-----|-------|-----|---------------------|---------------------|
| | | | | Start | End | Start | End | | |
| 17 | 99 | Chowchilla River | NB | 4/15/2008 | 7 | 14 | | 34 | 444 |
| | | | | 4/16/2008 | 7 | 14 | | 43 | 521 |
| | | | | 4/17/2008 | 7 | 14 | | 46 | 454 |
| 18 | 58 | Keene | EB | 4/21/2008 | 12 | 13 | | | 80 |
| | | | | 4/22/2008 | 9 | 9 | | | 18 |
| | | | | 4/23/2008 | 10 | 12 | | | 46 |
| | | | | 5/19/2008 | 9 | 16 | | 71 | 263 |
| | | | | 5/20/2008 | 6 | 15 | | 85 | 524 |
| 19 | 58 | Cache Creek | WB | 5/21/2008 | 7 | 12 | | 74 | |
| | | | | 4/21/2008 | 9 | 16 | | 67 | 349 |
| | | | | 4/22/2008 | 7 | 15 | | 90 | 482 |
| | | | | 4/23/2008 | 7 | 14 | | 70 | |
| Roadside/overpass Survey Sites | | | | | | | | | |
| 21 | I-710 | Near Jct 105 | NB/SB | 2/26/2008 | 8 | 12 | | | 1543 |
| | | | | 2/27/2008 | 6 | 11 | | | 3163 |
| | | | | 2/28/2008 | 5 | 10 | | | 2044 |
| 23 | I-605 | Near Jct. 5 | NB/SB | 3/4/2008 | 6 | 13 | | | 1972 |
| | | | | 3/5/2008 | 5 | 13 | | | 4823 |
| | | | | 3/6/2008 | 8 | 14 | | | 3848 |
| 25 | I-105 | Near Jct 19 | EB/WB | 3/12/2008 | 8 | 13 | | | 1269 |
| | | | | 3/13/2008 | 8 | 13 | | | 1854 |
| 26 | CA-60 | Near Jct 710 | EB/WB | 3/17/2008 | 8 | 13 | | | 1153 |
| 30 | I-15 | South of Jct CA 60 | NB/SB | 4/1/2008 | 9 | 15 | | | 863 |
| 34 | CA-91 | Near Jct 215 | EB/WB | 4/7/2008 | 9 | 9 | | | 87 |
| | | | | 4/9/2008 | 8 | 13 | | | 459 |
| 35 | CA-60 | Near Jct 91 | EB/WB | 4/8/2008 | 8 | 14 | | | 1293 |
| | | | | 4/9/2008 | 14 | 14 | | | 1 |
| 38 | CA-237 | Near Great America Parkway | EB/WB | 4/13/2008 | 9 | 15 | | | 241 |
| | | | | 4/14/2008 | 9 | 15 | | | 133 |
| 39 | I-880 | Near Oakland/Jct Rte 77 | NB/SB | 4/15/2008 | 8 | 14 | | | 2892 |
| 40 | I-280 | Near Daly City/Ocean Ave | NB/SB | 4/16/2008 | 8 | 15 | | | 679 |
| 41 | US-101 | Near Jct 84 | NB/SB | 4/17/2008 | 8 | 15 | | | 1521 |
| 42 | I-5 | At Arena Bl (95834) | NB/SB | 4/21/2008 | 8 | 16 | | | 2644 |
| 47 | CA-99 | Fowler | NB/SB | 4/29/2008 | 8 | 23 | | | 2814 |
| 49 | CA-198 | Near Jct 41 | EB/WB | 4/30/2008 | 13 | 24 | | | 419 |
| 50 | CA-46 | Near Jct 43 | EB/WB | 5/8/2008 | 8 | 14 | | | 405 |
| 51 | Etiwanda and the 60 | | | 4/15/2008 | 6 | 13 | | 162 | |
| 52 | Riverside and Agua Mansa (colton) | | | 4/16/2008 | 6 | 12 | | 106 | |
| 53 | 91 Fwy and the 15 Fwy (Corona) | | | 4/17/2008 | 6 | 9 | | 35 | |
| Total | | | | | | | | 6215 | 54570 |

2) Regional Allocation Based on OD Survey Data

To analyze OD data staff used the NORTAD (BTS, 1998) roadway network, which is comprised of the North American Transportation Atlas, as well as highway networks representing Mexico and Canada. This roadway network included an estimate of the congested speed and length of each roadway link. The United States Geological Survey Geographic Names Information System (USGS, 2009) and other internet sources were used to assign GIS coordinates for each origin and destination in the OD database. Using ArcGIS Network Analyst and congested speeds for each link staff estimated the route traveled for each origin-destination pair in the OD database using both a fastest path and a shortest path algorithm. Results were assessed visually using GIS, and quantitatively by calculating VMT by truck category and air basin. Because the number of samples collected at each survey location is not proportional to the number of trips passing the specific location, staff scaled up the trip-VMT based on the Average Annual Daily Truck Traffic (AADTT) at the locations where the trips were

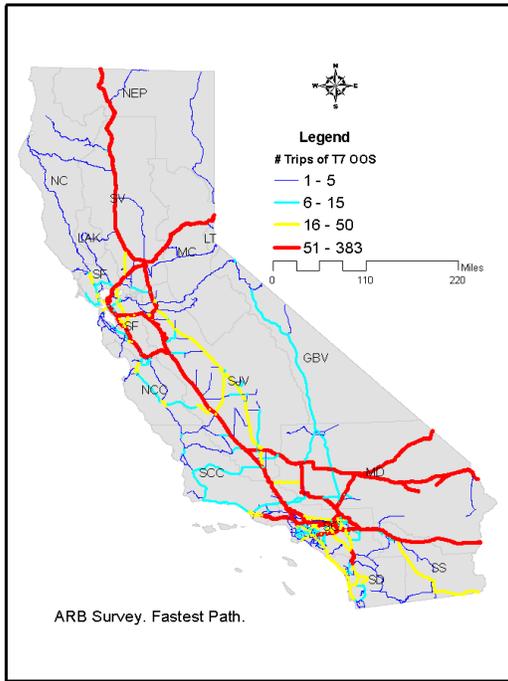
observed. Staff used Caltrans reported AADTT for location on state highways⁵ (Caltrans, 2009) and FAF2 AADTT for off-highway locations (FHWA, 2008).

Results showed that many trucks traveling in California are also participating in trucking activities across the United States. More importantly, results suggested interstate trucks have a different travel pattern from trucks that do not travel outside of California, and that California registered single-unit trucks have a different travel pattern from California-registered tractors. While this finding is relatively intuitive, the field study data represent the first attempt at a quantitative study to assess differences in travel patterns across different types of trucking. Figure 7 compares the OD results visually across four inventory categories.

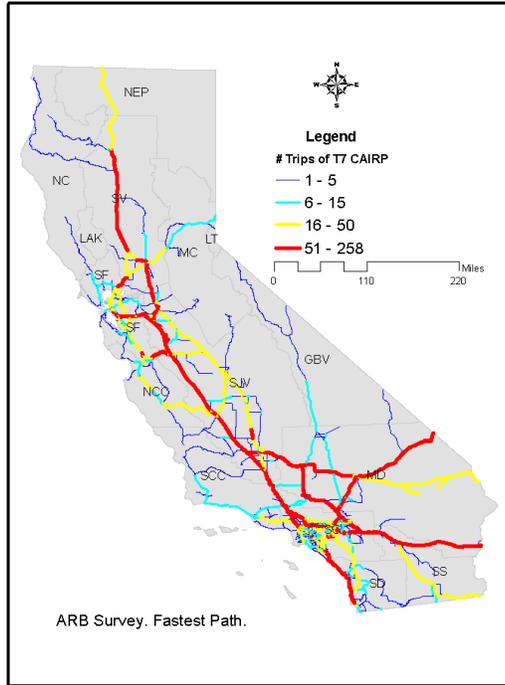
⁵ Caltrans Truck Traffic report only provides AADTT on California State Highways.

Figure 7. Estimated Travel Pattern by Inventory Category

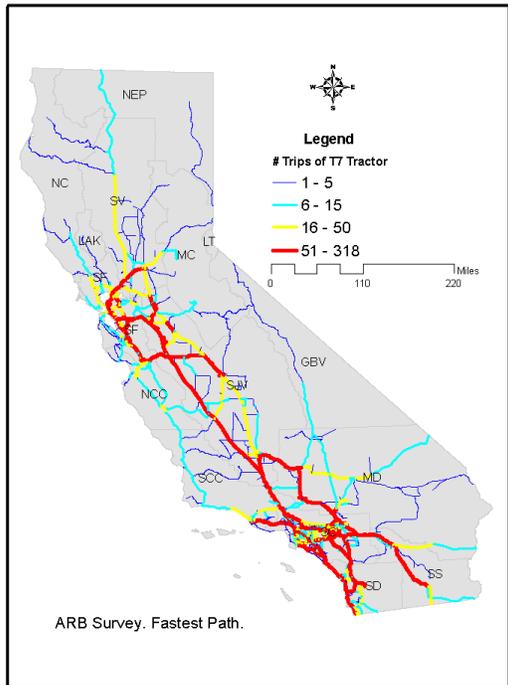
HHDDT Out-of-State



HHDDT CAIRP



HHDDT Tractor



MHDDT

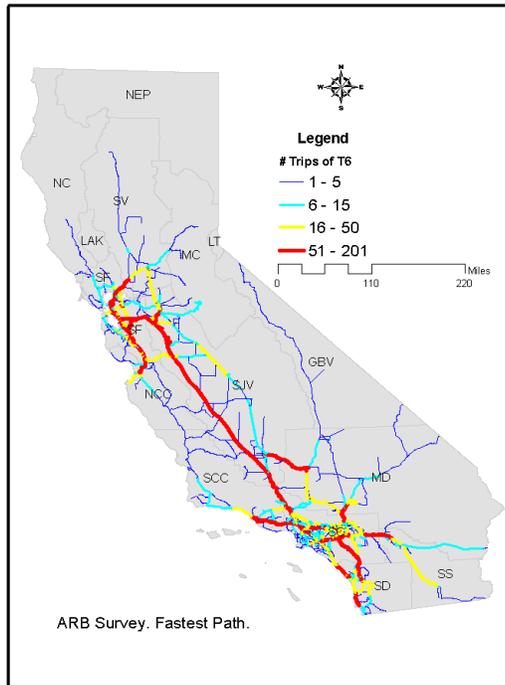


Figure 8 compares results from all trucking categories in the OD data to results generated through the US Freight Analysis Framework (FAF2), (FHWA, 2008). Results are generally similar, and reflect differences between the various approaches and mix of vehicles contained in each study. Table 9 presents the percentage of travel by air basin estimated using the OD data by inventory category.

Figure 8. Heavy Duty Truck Travel Patterns: ARB OD Survey Results vs. FAF2

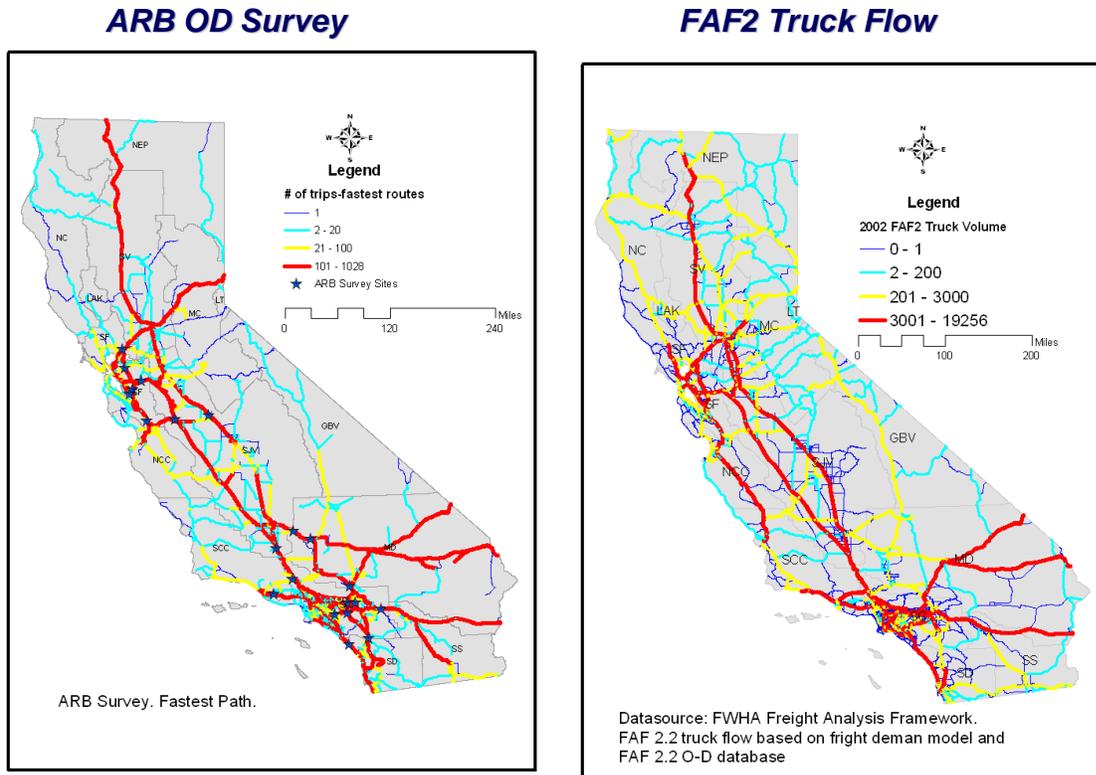


Table 9. Truck VMT Regional Allocation Factors by Fleet Based on OD Analysis

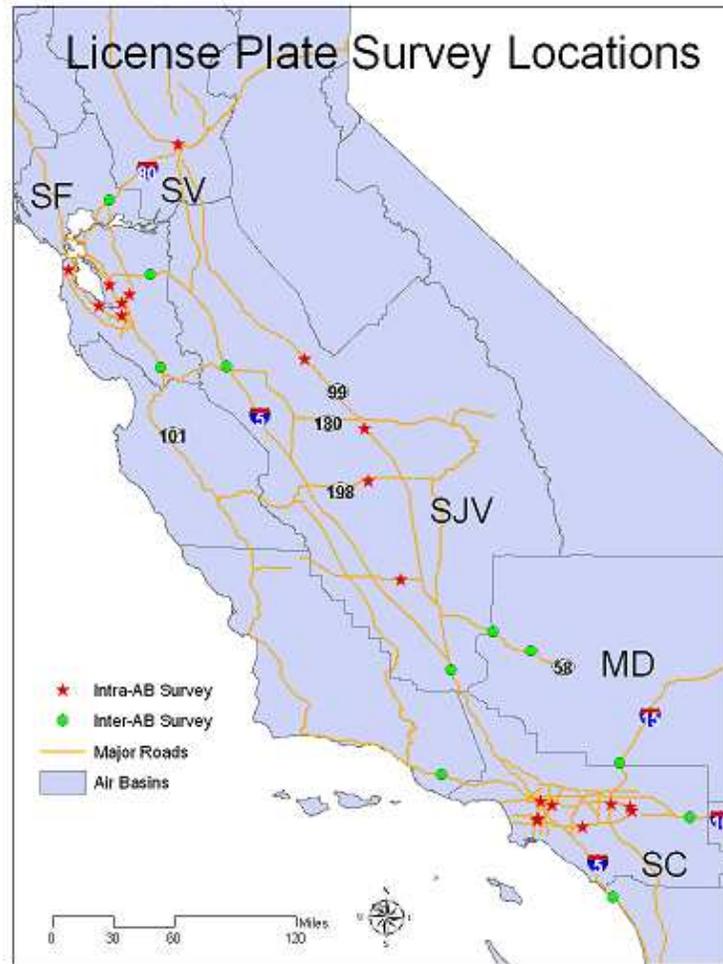
| Air Basin | HHDDT OOS | HHDDT CA IRP | HHDDT Tractor | HHDDT Single | HHDDT All | MHDDT All |
|---------------------|------------------|---------------------|----------------------|---------------------|------------------|------------------|
| Great Basins Valley | 0.3% | 0.6% | 0.2% | 0.2% | 0.3% | 0.4% |
| Lake County | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Lake Tahoe | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Mountain Counties | 2.6% | 0.9% | 0.6% | 0.6% | 1.6% | 0.9% |
| Mojave Desert | 27.7% | 19.3% | 5.8% | 10.4% | 19.1% | 11.7% |
| North Coast | 0.4% | 0.3% | 0.4% | 0.7% | 0.4% | 0.8% |
| North Central Coast | 0.4% | 0.5% | 0.8% | 0.9% | 0.6% | 0.9% |
| Northeast Plateau | 3.2% | 2.6% | 0.4% | 0.0% | 2.2% | 0.1% |
| South Coast | 14.3% | 21.1% | 28.6% | 24.9% | 20.2% | 26.2% |
| South Central Coast | 0.5% | 0.6% | 1.0% | 2.2% | 0.7% | 1.8% |
| San Diego County | 1.3% | 2.9% | 6.7% | 3.9% | 3.2% | 5.0% |
| San Francisco Bay | 4.5% | 4.0% | 10.8% | 15.1% | 6.4% | 12.3% |
| San Joaquin Valley | 29.2% | 33.1% | 37.9% | 36.9% | 32.8% | 30.7% |
| Salton Sea | 2.8% | 3.8% | 3.1% | 2.6% | 3.1% | 4.8% |
| Sacramento Valley | 12.8% | 10.4% | 3.7% | 1.6% | 9.3% | 4.4% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |

3) OD and LP Survey Data Analysis

In addition to evaluating the OD analysis results, staff developed an alternative analysis using both the LP and OD data. The general approach was to estimate the number of inter air basin trips and intra air basin trips by inventory category and air basin, and to multiply those trip estimates by an assumed trip length within each air basin to estimate VMT by air basin for each inventory truck category. These results could then be used to develop a percent VMT allocation by inventory truck category.

The first step in this process was to separate LP data collection sites into two types: inter-regional sites and intra-regional sites. Inter-regional sites are located near the border of one air basin and were likely to capture inter-regional truck trips, while intra-regional sites were located in the middle of air basins and were likely to capture trips within a single air basin. Interregional site are marked with circles and intra-regional sites are marked with stars as shown in Figure 9.

Figure 9. License Plate Survey Locations by Trip Type



License plates surveyed were then cross-referenced to the California DMV registration database to obtain vehicle registration information. Based on the location of vehicle registration, staff separated data at each site into trucks traveling inside or outside of the air basin in which they were registered. Since the survey was conducted in selected urban areas (South Coast and Bay area) and rural areas (Mojave Desert and San Joaquin Valley) in California, we also grouped the LPs into urban and rural groups. The average fractions of trips by trucks registered inside vs. outside of an air basin observed at inter-air basin locations and intra-air basin locations, respectively, are shown in Table 10, where “inAB” refers to trucks traveling within their air basin of registration and “outAB” refers to trucks traveling outside their air basin of registration.

Table 10. Average Percentages of Truck License Plates by Registered Air Basin for Intra and Inter Air Basin Survey Location Groups

| Air Basin Group | Survey Location | T7CAIRP | | T7Tractor | | T7Single | | T6 | |
|-----------------|-----------------|---------|-------|-----------|-------|----------|-------|------|-------|
| | | inAB | outAB | inAB | outAB | inAB | outAB | inAB | outAB |
| SC | Inter | 0.34 | 0.66 | 0.37 | 0.63 | 0.43 | 0.57 | 0.39 | 0.61 |
| SC | Intra | 0.76 | 0.24 | 0.89 | 0.11 | 0.92 | 0.08 | 0.90 | 0.10 |
| SF | Inter | 0.20 | 0.80 | 0.40 | 0.60 | 0.48 | 0.52 | 0.46 | 0.54 |
| SF | Intra | 0.27 | 0.73 | 0.56 | 0.44 | 0.70 | 0.30 | 0.76 | 0.24 |
| MD | Inter | 0.15 | 0.85 | 0.09 | 0.91 | 0.06 | 0.94 | 0.10 | 0.90 |
| SJV | Inter | 0.25 | 0.75 | 0.32 | 0.68 | 0.40 | 0.70 | 0.22 | 0.81 |
| SJV | Intra | 0.52 | 0.48 | 0.71 | 0.29 | 0.82 | 0.18 | 0.66 | 0.34 |
| URBAN | Inter | 0.28 | 0.72 | 0.38 | 0.62 | 0.45 | 0.55 | 0.41 | 0.59 |
| URBAN | Intra | 0.63 | 0.37 | 0.80 | 0.20 | 0.86 | 0.14 | 0.86 | 0.14 |
| RURAL | Inter | 0.22 | 0.78 | 0.25 | 0.75 | 0.26 | 0.74 | 0.17 | 0.83 |
| RURAL | Intra | 0.52 | 0.48 | 0.71 | 0.29 | 0.82 | 0.18 | 0.66 | 0.34 |

Staff categorized three types of trips for each area basin and inventory category: trips within an air basin by local trucks (trucks registered in that air basin), inter-air basin trips by local trucks, and inter-air basin trips by non-local trucks (trucks registered outside of the air basin of travel). Staff assumed that the distribution of the number of trips is consistent with the distribution of the overall truck population, and that at intra-regional sites the observed ratio of trips between local trucks and non-local trucks represented the real ratio of population of trucks registered in vs. out of the specific air basin. The population of trucks registered in each air basin was obtained from analyzing DMV truck registration data.

The non-local truck population was estimated using the local truck population and the ratio of non-local to local trips observed at intra-regional sites (Equation 2). Next, staff assumed that at inter-regional sites, the observed ratio of trips by local trucks vs. non-local trucks represented the ratio of population between local trucks making inter-regional trips and non-local trucks making inter-regional trips. Thus the population of local trucks making inter-regional trips was derived using the population of non-local trucks and the ratio of trips observed at inter-regional sites (Equation 3). Finally, the population of local-trucks that make inter-regional trips is estimated as the difference between total registered population in the air basin and the population of local trucks making inter-regional trips (Equation 4). Staff also assumed that the existence of non-local trucks traveling completely within an air basin is insignificant and distributed evenly statewide, and therefore will not affect the analysis.

$$PIO_{ab,fl} = P_{ab,fl} * \left(\frac{RAO_{ab,fl}}{RAI_{ab,fl}} \right) \quad \text{Equation 2}$$

$$PII_{ab,fl} = PIO_{ab,fl} * \left(\frac{RII_{ab,fl}}{RIO_{ab,fl}} \right) \quad \text{Equation 3}$$

$$PIR_{ab,fl} = P_{ab,fl} - PII_{ab,fl} \quad \text{Equation 4}$$

where,

PIO = the population of trucks traveling in and out of an air basin other than the air basin in which they are registered.

ab = air basin

fl = inventory category

P = truck population registered in an air basin by inventory category

RAO = the average fraction of trucks traveling in an air basin other than their registration air basin, seen at an intra-air basin survey location

RAI = the average fraction of trucks traveling in their registration air basin, seen at an intra-air basin survey location.

PII = the population of trucks traveling in and out of their registration air basin, seen at an inter-air basin survey location

RII = the average fraction of trucks traveling in an air basin where they are registered, seen at an inter-air basin survey location

RIO = the average fraction of trucks traveling in an air basin other than their registration air basin, seen at an inter-air basin survey location

PIR = the population of trucks traveling completely in their registration air basin

The relative ratio between the above populations reflected the relative ratio of trips by corresponding population. It should be noted that it is the relative ratio, not the absolute value that impacts the regional allocation. Table 11, Table 12, and Table 13 display estimated truck population (surrogate for trips) by trip type and inventory category.

Table 11. Intra Air Basin Truck Population by Trucks Registered in the Air Basin

| Air Basin | HHDDT CA IRP | HHDDT In- State Tractor | HHDDT In- State Single | MHDDT All |
|---------------------|-------------------------|--|-----------------------------------|----------------------|
| South Coast | 168,447 | 240,514 | 112,619 | 2,471,067 |
| San Francisco | 6,829 | 34,336 | 30,360 | 828,013 |
| Mojave Desert | 16,845 | 10,110 | 8,409 | 106,131 |
| San Joaquin Valley | 51,421 | 102,215 | 45,940 | 667,300 |
| Great Basins Valley | 255 | 316 | 462 | 3,894 |
| Lake County | 44 | 462 | 673 | 6,368 |
| Lake Tahoe | 444 | 21 | 131 | 3,468 |
| Mountain Counties | 2,585 | 4,281 | 7,811 | 69,687 |
| North Coast | 1,548 | 4,057 | 6,914 | 38,309 |
| North Central Coast | 6,047 | 7,450 | 7,051 | 90,369 |
| Northeast Plateau | 1,535 | 1,069 | 1,357 | 9,917 |
| Sacramento Valley | 25,513 | 33,221 | 28,210 | 354,499 |
| South Central Coast | 3,963 | 13,572 | 14,200 | 243,396 |
| San Diego County | 12,124 | 34,952 | 21,444 | 419,807 |
| Salton Sea | 4,613 | 10,455 | 5,494 | 76,899 |

Table 12. Inter Air Basin Truck Population by Trucks Registered in the Air Basin

| Air Basin | HHDDT CA IRP | HHDDT In- State Tractor | HHDDT In- State Single | MHDDT All |
|---------------------|-------------------------|------------------------------------|-----------------------------------|------------------|
| South Coast | 32,887 | 20,005 | 8,320 | 193,157 |
| San Francisco | 15,872 | 37,841 | 20,264 | 307,155 |
| Mojave Desert | 3,406 | 411 | 124 | 6,541 |
| San Joaquin Valley | 22,772 | 24,695 | 6,798 | 110,492 |
| Great Basins Valley | 151 | 111 | 105 | 2,250 |
| Lake County | 26 | 161 | 153 | 3,680 |
| Lake Tahoe | 263 | 7 | 30 | 2,004 |
| Mountain Counties | 439 | 598 | 1,002 | 7,753 |
| North Coast | 916 | 1,417 | 1,577 | 22,139 |
| North Central Coast | 3,578 | 2,602 | 1,608 | 52,223 |
| Northeast Plateau | 908 | 373 | 309 | 5,731 |
| Sacramento Valley | 15,094 | 11,600 | 6,433 | 204,861 |
| South Central Coast | 1,371 | 2,185 | 1,214 | 30,172 |
| San Diego County | 2,282 | 3,107 | 1,271 | 15,297 |
| Salton Sea | 1,596 | 1,683 | 470 | 9,533 |

Table 13. Inter Air Basin Truck Population by Trucks Registered out of the Air Basin

| Air Basin | HHDDT OOS | HHDDT CA IRP | HHDDT Tractor | HHDDT Single | MHDDT All |
|---------------------|-----------|--------------|---------------|--------------|-----------|
| South Coast | 1,319,639 | 64,380 | 33,720 | 10,997 | 299,380 |
| San Francisco | 257,693 | 62,613 | 56,087 | 21,777 | 367,524 |
| Mojave Desert | 153,728 | 19,005 | 4,358 | 1,927 | 58,710 |
| San Joaquin Valley | 728,206 | 69,627 | 52,563 | 11,909 | 405,282 |
| Great Basins Valley | 3,341 | 381 | 177 | 128 | 3,201 |
| Lake County | 3,625 | 66 | 258 | 187 | 5,236 |
| Lake Tahoe | 2,139 | 663 | 12 | 36 | 2,851 |
| Mountain Counties | 39,897 | 1,108 | 956 | 1,218 | 11,031 |
| North Coast | 39,212 | 2,312 | 2,267 | 1,917 | 31,498 |
| North Central Coast | 67,631 | 9,033 | 4,163 | 1,955 | 74,300 |
| Northeast Plateau | 13,249 | 2,293 | 597 | 376 | 8,154 |
| Sacramento Valley | 286,578 | 38,108 | 18,564 | 7,823 | 291,464 |
| South Central Coast | 87,128 | 5,006 | 6,526 | 3,481 | 142,547 |
| San Diego County | 167,315 | 8,329 | 9,280 | 3,643 | 72,270 |
| Salton Sea | 58,024 | 5,827 | 5,027 | 1,347 | 45,037 |

Next staff converted the estimated population of trucks by trip type, air basin and fleet category to VMT by trip type, air basin and fleet category. This required estimation of average travel distance within each air basin for each trip type. Average travel distances per trip were estimated using the OD data. Each OD record was cross-referenced to the DMV database to identify the air basin in which each truck was registered. Using these data, staff calculated the average travel miles by travel air basin, trip type and inventory category. In evaluating the OD data, staff found that intra-air basin trips were under-represented. This was a consequence of conducting surveys at weigh stations which tend to be located in between air basins and capture inter-regional travel. As a result, staff estimated an average intra-air basin trip distance based on travel demand model output developed by SCAG and the San Joaquin Valley transportation agencies in their heavy-duty truck models. Average travel miles of intra-air basin trips by HHDDT and MHDDT were estimated to be 25 and 20 miles, respectively, in San Joaquin Valley air basin (Cambridge Systematics, 2008), and 15 and 13 miles, respectively, in South Coast air basin (SCAG, 1999). For inter-air basin trips, that is, trips traversing multiple air basins, staff divided trips into segments in each air basin and compiled the average travel miles in each air basin by trip type. For interstate trips, only travel miles accrued within California were used. Table 14 and Table 15 show average travel miles within a specific air basin for inter air basin truck trips by local trucks and those by non-local trucks, respectively.

Table 14. Average Travel Miles for Inter Air Basin Truck Trips by Trucks Registered in the Air Basin

| Air Basin | HHDDT CA IRP | HHDDT In-State Tractor | HHDDT In-State Single | MHDDT All |
|---------------------|--------------|------------------------|-----------------------|-----------|
| South Coast | 97 | 85 | 59 | 67 |
| San Francisco | 62 | 53 | 61 | 61 |
| Mojave Desert | 104 | 56 | 28 | 40 |
| San Joaquin Valley | 182 | 138 | 70 | 77 |
| Great Basins Valley | 115 | 74 | 39 | 54 |
| Lake County | 99 | 74 | 39 | 54 |
| Lake Tahoe | 99 | 74 | 39 | 54 |
| Mountain Counties | 99 | 74 | 39 | 33 |
| North Coast | 99 | 74 | 39 | 54 |
| North Central Coast | 55 | 52 | 28 | 39 |
| Northeast Plateau | 82 | 74 | 39 | 54 |
| Sacramento Valley | 100 | 58 | 44 | 46 |
| South Central Coast | 48 | 40 | 46 | 33 |
| San Diego County | 75 | 77 | 65 | 47 |
| Salton Sea | 107 | 102 | 17 | 107 |

Table 15. Average Travel Miles for Inter Air Basin Truck Trips by Trucks Not Registered in the Air Basin

| Air Basin | HHDDT OOS | HHDDT CA IRP | HHDDT In-State Tractor | HHDDT In-State Single | MHDDT All |
|---------------------|-----------|--------------|------------------------|-----------------------|-----------|
| South Coast | 88 | 108 | 97 | 70 | 75 |
| San Francisco | 66 | 56 | 56 | 56 | 56 |
| Mojave Desert | 169 | 135 | 91 | 68 | 80 |
| San Joaquin Valley | 207 | 190 | 149 | 189 | 163 |
| Great Basins Valley | 160 | 127 | 68 | 131 | 118 |
| Lake County | 97 | 100 | 66 | 76 | 77 |
| Lake Tahoe | 13 | 100 | 2 | 76 | 77 |
| Mountain Counties | 65 | 47 | 36 | 61 | 38 |
| North Coast | 72 | 114 | 65 | 65 | 82 |
| North Central Coast | 53 | 57 | 45 | 33 | 38 |
| Northeast Plateau | 83 | 81 | 83 | 76 | 82 |
| Sacramento Valley | 136 | 129 | 75 | 52 | 66 |
| South Central Coast | 45 | 48 | 40 | 48 | 41 |
| San Diego County | 55 | 64 | 61 | 59 | 53 |
| Salton Sea | 66 | 73 | 69 | 40 | 61 |

To calculate regional allocation factors by inventory category using the LP and OD study data, staff multiplied the estimated trips per air basin by inventory category by the assumed average travel miles per trip by air basin by inventory category. Results are shown in Table 16.

Table 16. Truck VMT Regional Allocation Factors by Fleet Based on OD/LP Analysis

| Air Basin | HHDDT OOS | HHDDT CAIRP | HHDDT In-State Tractor | HHDDT In-State Single | HHDDT All | MHDDT All |
|---------------------|-----------|-------------|------------------------|-----------------------|-----------|-----------|
| South Coast | 30.4% | 24.9% | 24.1% | 21.1% | 26.9% | 23.2% |
| San Francisco | 4.3% | 10.5% | 15.9% | 20.7% | 9.9% | 17.2% |
| Mojave Desert | 7.2% | 6.6% | 1.9% | 2.5% | 5.3% | 2.4% |
| San Joaquin Valley | 40.4% | 36.6% | 38.7% | 27.8% | 38.0% | 30.1% |
| Great Basins Valley | 0.1% | 0.1% | 0.1% | 0.2% | 0.1% | 0.2% |
| Lake County | 0.1% | 0.0% | 0.1% | 0.3% | 0.1% | 0.2% |
| Lake Tahoe | 0.0% | 0.2% | 0.0% | 0.1% | 0.0% | 0.1% |
| Mountain Counties | 0.7% | 0.3% | 0.5% | 2.2% | 0.7% | 0.7% |
| North Coast | 0.7% | 0.8% | 1.0% | 2.6% | 1.0% | 1.6% |
| North Central Coast | 1.0% | 1.7% | 1.4% | 2.1% | 1.3% | 2.3% |
| Northeast Plateau | 0.3% | 0.6% | 0.3% | 0.5% | 0.4% | 0.4% |
| Sacramento Valley | 10.3% | 13.9% | 8.1% | 10.0% | 10.5% | 12.3% |
| South Central Coast | 1.0% | 0.8% | 1.9% | 4.1% | 1.5% | 4.0% |
| San Diego County | 2.4% | 1.7% | 3.7% | 4.4% | 2.8% | 3.4% |
| Salton Sea | 1.0% | 1.4% | 2.2% | 1.4% | 1.4% | 1.8% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |

4) Discussion of Field Study Results

The ARB field study is the most comprehensive study of its kind that has been conducted to date on truck travel in California. Results show significant differences in truck travel between broad types of trucking operations in California that are important to consider when developing an emissions inventory representing heavy duty trucks. Despite the large amount of data collected there are still some limitations to consider. For example, it was necessary to obtain OD data primarily at weigh stations. This was done for practical purposes as conducting OD surveys at most roadside locations is disruptive to traffic and places survey staff unacceptably close to traffic. However most weigh stations are located on roadways on the outskirts of urban areas and as a result will see more inter-regional than intra-regional trips. As was observed in the LP data, most trips at roadside locations were intra-air basin trips traveled by trucks that are also registered in the air basin – local trips for which OD data were limited. In another example, while many sites were sampled, some regions, especially rural areas such as the northern portion of the state were not well covered by the field study due to staffing limitations on data collection. Regional allocation factors developed to represent these areas may be more uncertain as a result.

In light of these limitations, staff evaluated field study results along with other corroborative data on an inventory category specific basis to decide on regional allocation factors for each category.

E. Regional Allocation of Activity and Emissions

Staff derived a regional allocation for each truck category by analyzing relevant field study results and corroborative data sources specific to the trucking type or vocation.

1) Interstate Trucks

Table 17 compares the regional distribution factors developed using the OD and OD/LP approaches to regional distribution assumptions in EMFAC2002 and EMFAC2007.

Table 17. Comparison of CA Interstate Truck VMT Regional Allocations

| Air Basin | OD | LP/OD | EMFAC2002 | EMFAC2007 | Assumed |
|---------------------|-------|-------|-----------|-----------|---------|
| Great Basins Valley | 0.6% | 0.1% | 0.2% | 0.6% | 0.6% |
| Lake County | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% |
| Lake Tahoe | 0.0% | 0.2% | 0.1% | 0.1% | 0.1% |
| Mountain Counties | 0.9% | 0.3% | 1.1% | 1.8% | 1.8% |
| Mojave Desert | 19.3% | 6.7% | 1.5% | 15.1% | 15.1% |
| North Coast | 0.3% | 0.8% | 1.3% | 1.4% | 1.4% |
| North Central Coast | 0.5% | 1.7% | 2.5% | 1.8% | 1.8% |
| Northeast Plateau | 2.6% | 0.6% | 0.3% | 1.5% | 1.5% |
| South Coast | 21.1% | 25.2% | 36.9% | 20.0% | 20.0% |
| South Central Coast | 0.6% | 0.8% | 2.6% | 1.3% | 1.3% |
| San Diego County | 2.9% | 1.8% | 7.5% | 3.8% | 3.8% |
| San Francisco Bay | 4.0% | 9.1% | 17.3% | 7.8% | 7.8% |
| San Joaquin Valley | 33.1% | 37.2% | 17.6% | 28.9% | 28.9% |
| Salton Sea | 3.8% | 1.4% | 1.8% | 6.5% | 6.5% |
| Sacramento Valley | 10.4% | 14.1% | 9.3% | 9.6% | 9.6% |
| Total | 100% | 100% | 100% | 100% | 100% |

ARB staff revised the VMT distribution for HHDDT in EMFAC2007, as documented in ARB (2006a). The document described the redistribution of HHDDT VMT from a registration to a travel basis. The travel based VMT distribution was estimated using a combination of data from a survey conducted by California Department of Transportation (Caltrans) in 1999, and modeled information from MVSTAFF, an annual report developed by Caltrans. Detailed descriptions of the methodologies in developing the VMT redistribution can be found in the Technical Memo. Although the distribution was applied to the entire HHDDT fleet in EMFAC2007, the underlying Caltrans survey was geared toward long-haul trucks since the survey data were collected at weigh stations, agricultural inspection stations and rest areas.

The ARB 2008 field study was designed to focus on intra-California trips. Compared to the Caltrans 1999 study, the ARB field study captured more intra-state trips and local trips in both origin-destination and license plate data. In particular, two thirds of the license plate data were collected at roadside locations where intra-state trips were more

likely to be captured. As a result, regional allocations based on the OD and LP analysis is not appropriate for distributing inter-state trip VMT. Staff chose to use the regional allocation developed for HHDDT VMT redistribution in EMFAC2007 for all interstate trucks, including out-of-state registered trucks and California registered inter-state trucks. The “assumed” allocations in the table were used for interstate fleets.

2) Heavy-Heavy Duty In-State Tractors

Table 18 compares regional distribution factors developed using the OD and OD/LP approaches to assumptions in EMFAC2002 and EMFAC2007.

Table 18. Comparison of CA In-State Tractor HHDT VMT Regional Allocations

| Air Basin | OD | LP/OD | EMFAC2002 | EMFAC2007 | Assumed |
|---------------------|-------|-------|-----------|-----------|---------|
| Great Basins Valley | 0.2% | 0.1% | 0.2% | 0.6% | 0.16% |
| Lake County | 0.0% | 0.1% | 0.1% | 0.0% | 0.06% |
| Lake Tahoe | 0.0% | 0.0% | 0.1% | 0.1% | 0.00% |
| Mountain Counties | 0.6% | 0.5% | 1.1% | 1.8% | 0.56% |
| Mojave Desert | 5.8% | 1.9% | 1.5% | 15.1% | 3.83% |
| North Coast | 0.4% | 1.0% | 1.3% | 1.4% | 0.71% |
| North Central Coast | 0.8% | 1.4% | 2.5% | 1.8% | 1.13% |
| Northeast Plateau | 0.4% | 0.3% | 0.3% | 1.5% | 0.32% |
| South Coast | 28.6% | 24.1% | 36.9% | 20.0% | 26.34% |
| South Central Coast | 1.0% | 1.9% | 2.6% | 1.3% | 1.49% |
| San Diego County | 6.7% | 3.7% | 7.5% | 3.8% | 5.20% |
| San Francisco Bay | 10.8% | 15.9% | 17.3% | 7.8% | 13.34% |
| San Joaquin Valley | 37.9% | 38.7% | 17.6% | 28.9% | 38.32% |
| Salton Sea | 3.1% | 2.2% | 1.8% | 6.5% | 2.61% |
| Sacramento Valley | 3.7% | 8.1% | 9.3% | 9.6% | 5.93% |
| Total | 100% | 100% | 100% | 100% | 100% |

The HHDDT in-state tractor fleet category is a mix of vocational trucks that are dedicated to specific industries/services and travel mostly in California close to their base of operations, and trucking companies that regularly travel across California. Therefore neither a travel based nor a registration based allocation would fully describe the HHDDT tractor travel. ARB field study results are particularly relevant to this category.

Although the scale of OD survey conducted by ARB in 2008 was smaller than Caltrans survey in 1999, it was designed to capture both inter-regional and local trips by different inventory categories, and was supplemented by the large-scale LP survey. Staff used the average of the results from OD survey, and OD/LP survey for the regional allocation as shown in Table 18.

3) Heavy-Heavy Duty In-State Single-Unit Trucks

Staff believes the vast majority of single-unit trucks make short haul trips because the trucks are generally used for local delivery or vocational applications such as street

sweeping, liquids transport, drilling and other uses. These types of trips were under-represented in both the Caltrans 1999 study and the ARB field study. The degree to which local trips were under-estimated is highly uncertain and depends on the selection of survey locations. Therefore, regional allocations developed based on these survey data are not appropriate for allocating single-unit truck VMT. Staff assumed that single-unit trucks travel mostly in their registered air basin and applied a registration-based regional allocation method. This assumption was supported by our observations in the ARB field study. Staff developed registration populations by air basin from DMV data after excluding specific fleets including agricultural trucks and construction trucks, and multiplied populations with age-specific accrual rates to derive VMT by registration area basin. Table 19 presents regional distribution factors developed using the OD and OD/LP approaches, regional distribution assumptions in EMFAC2002 and EMFAC2007 and the one developed in this analysis.

Table 19. Comparison of CA In-state Single-Unit HHDT VMT Regional Allocations

| Air Basin | OD | LP/OD | EMFAC2002 | EMFAC2007 | Assumed |
|---------------------|-------|-------|-----------|-----------|---------|
| Great Basins Valley | 0.2% | 0.2% | 0.2% | 0.6% | 0.1% |
| Lake County | 0.0% | 0.3% | 0.1% | 0.0% | 0.1% |
| Lake Tahoe | 0.0% | 0.1% | 0.1% | 0.1% | 0.1% |
| Mountain Counties | 0.6% | 2.2% | 1.1% | 1.8% | 2.5% |
| Mojave Desert | 10.4% | 2.5% | 1.5% | 15.1% | 1.6% |
| North Coast | 0.7% | 2.6% | 1.3% | 1.4% | 2.4% |
| North Central Coast | 0.9% | 2.1% | 2.5% | 1.8% | 2.3% |
| Northeast Plateau | 0.0% | 0.5% | 0.3% | 1.5% | 0.0% |
| South Coast | 24.9% | 21.1% | 36.9% | 20.0% | 40.7% |
| South Central Coast | 2.2% | 4.1% | 2.6% | 1.3% | 4.3% |
| San Diego County | 3.9% | 4.4% | 7.5% | 3.8% | 7.7% |
| San Francisco Bay | 15.1% | 20.7% | 17.3% | 7.8% | 18.0% |
| San Joaquin Valley | 36.9% | 27.8% | 17.6% | 28.9% | 10.1% |
| Salton Sea | 2.6% | 1.4% | 1.8% | 6.5% | 1.1% |
| Sacramento Valley | 1.6% | 10.0% | 9.3% | 9.6% | 9.0% |
| Total | 100% | 100% | 100% | 100% | 100% |

4) Medium-Heavy Duty In-State Trucks

Like HHDDT single-unit trucks, MHDDT instate trucks mostly make local delivery or vocational trips that were under-represented in both the Caltrans 1999 and ARB 2008 OD surveys. Staff applied the registration-based regional allocation method to medium-heavy duty in-state trucks, including both GVWR above and below 26,000 lbs. Table 20 compares regional distribution factors developed using the OD and OD/LP approaches, regional distribution assumptions in EMFAC2002 and EMFAC2007 and the one developed in this analysis.

Table 20. Comparison of CA In-State MHDDT VMT Regional Allocations

| Air Basin | OD | LP/OD | EMFAC2002 | EMFAC2007 | Assumed |
|---------------------|-------|-------|-----------|-----------|---------|
| Great Basins Valley | 0.4% | 0.2% | 0.2% | 0.1% | 0.1% |
| Lake County | 0.0% | 0.2% | 0.1% | 0.1% | 0.1% |
| Lake Tahoe | 0.0% | 0.1% | 0.1% | 0.1% | 0.1% |
| Mountain Counties | 0.9% | 0.7% | 1.1% | 0.9% | 1.1% |
| Mojave Desert | 11.7% | 2.4% | 1.5% | 2.2% | 1.4% |
| North Coast | 0.8% | 1.6% | 1.3% | 0.7% | 0.8% |
| North Central Coast | 0.9% | 2.3% | 2.5% | 2.6% | 2.0% |
| Northeast Plateau | 0.1% | 0.4% | 0.3% | 0.2% | 0.0% |
| South Coast | 26.2% | 23.2% | 36.9% | 42.5% | 44.5% |
| South Central Coast | 1.8% | 4.0% | 2.6% | 3.5% | 4.1% |
| San Diego County | 5.0% | 3.4% | 7.5% | 7.9% | 7.3% |
| San Francisco Bay | 12.3% | 17.2% | 17.3% | 17.1% | 19.0% |
| San Joaquin Valley | 30.7% | 30.1% | 17.6% | 12.1% | 9.9% |
| Salton Sea | 4.8% | 1.8% | 1.8% | 1.3% | 1.0% |
| Sacramento Valley | 4.4% | 12.3% | 9.3% | 8.7% | 8.6% |
| Total | 100% | 100% | 100% | 100% | 100% |

5) Drayage Trucks

Drayage trucks were not identified during the 2008 field study and as a result were not specifically analyzed as part of that study. The regional allocation of drayage truck emissions is based upon the emissions analysis developed for ARB's Drayage Truck Regulation (ARB, 2007a). As described in Appendix B of the Technical Support Document for the Drayage Truck Regulation, the regional allocations were based on OD surveys conducted by Ports of Los Angeles and Long Beach and a study done by the Metropolitan Transportation Commission in the Bay Area. Using the study results, staff estimated VMT in each air basin by the drayage trucks serving the ports and developed the regional allocations. These are shown in Table 21.

Table 21. Comparison of CA Drayage Truck Regional Allocations

| Air Basin | Los Angeles Ports/Railyards | Bay Are Ports/Railyards | Other Drayage Trucks |
|---------------------|--|------------------------------------|---------------------------------|
| Great Basins Valley | 0.0% | 0.0% | 0.0% |
| Lake County | 0.0% | 0.0% | 0.0% |
| Lake Tahoe | 0.0% | 0.0% | 0.0% |
| Mountain Counties | 0.0% | 2.0% | 0.0% |
| Mojave Desert | 4.3% | 0.0% | 0.0% |
| North Coast | 0.0% | 0.0% | 3.5% |
| North Central Coast | 0.0% | 1.7% | 0.0% |
| Northeast Plateau | 0.0% | 0.0% | 0.0% |
| South Coast | 81.7% | 0.0% | 0.0% |
| South Central Coast | 0.1% | 0.0% | 11.6% |
| San Diego County | 1.4% | 0.0% | 34.0% |
| San Francisco Bay | 0.0% | 63.6% | 28.8% |
| San Joaquin Valley | 8.8% | 28.2% | 18.3% |
| Salton Sea | 3.7% | 0.0% | 0.0% |
| Sacramento Valley | 0.0% | 4.5% | 3.9% |
| Total | 100% | 100% | 100% |

6) Construction Trucks

For construction fleets, staff assumed that the regional allocation is proportional to the regional rate of population growth. This surrogate is designed to reflect where populations are growing and therefore where construction is more likely to be focused. The Demographic Research Unit of California Department of Finance (DOF, 2009) provides population estimates and projections by county. The populations within counties were then distributed into air basins based on census data. Staff calculated the year to year increase in population within each air basin and used the fraction of the population growth in air basin versus statewide growth as a surrogate for construction fleets regional allocation. The resulting allocations are shown in Table 22 for calendar year 2008, and projected for 2020 and 2030 where DOF provided a population forecast. Staff interpolated regional allocation factors linearly between forecast years.

Table 22. Regional Allocation for Construction Fleets

| Air Basin | Calendar Year | | |
|---------------------|---------------|-------|-------|
| | 2008 | 2020 | 2030 |
| Great Basin Valleys | 0.0% | 0.1% | 0.1% |
| Lake County | 0.1% | 0.2% | 0.2% |
| Lake Tahoe | 0.2% | 0.2% | 0.2% |
| Mountain Counties | 0.3% | 1.5% | 1.2% |
| Mohave Desert | 2.4% | 3.4% | 3.2% |
| North Coast | 0.3% | 0.7% | 0.6% |
| North Central Coast | 1.7% | 1.6% | 1.7% |
| Northeast Plateau | 0.0% | 0.3% | 0.2% |
| South Coast | 35.4% | 37.7% | 31.9% |
| South Central Coast | 3.0% | 3.0% | 2.8% |
| San Diego | 10.7% | 6.5% | 7.8% |
| San Francisco Bay | 22.0% | 10.1% | 13.7% |
| San Joaquin Valley | 13.1% | 21.7% | 23.3% |
| Salton Sea | 3.0% | 3.8% | 3.3% |
| Sacramento Valley | 7.7% | 9.3% | 9.7% |
| Total | 100% | 100% | 100% |

7) Agricultural Trucks

ARB staff, in conjunction with agricultural trade associations, administered a survey to farmers, ranchers, and other agricultural businesses designed to identify and characterize trucks serving the agricultural sector. The results were used to develop population, age distribution and accrual rates as described in the Appendix G of the Technical Support Document (ARB, 2008). In addition to the characteristics in Appendix G, the survey also collected information regarding where the trucks had traveled. The results indicated that although most of the agricultural trucks traveled within one air basin boundary, about 30 percent of them did travel across air basins. The results, shown in Table 23 are generally consistent with the distribution of irrigated acreage given the 30 percent of agricultural trucks that travel across multiple regions. In this analysis, staff used the agricultural survey-based regional allocation factors.

Table 23. Regional Allocation for Agricultural Activities

| Air Basin | Irrigated Acreage | Agricultural Truck Survey | Assumed |
|---------------------|--------------------------|----------------------------------|----------------|
| Great Basins Valley | 0.3% | 0.3% | 0.3% |
| Lake County | 0.8% | 1.6% | 1.6% |
| Lake Tahoe | 0.0% | 0.0% | 0.0% |
| Mountain Counties | 1.1% | 2.1% | 2.1% |
| Mojave Desert | 5.3% | 0.7% | 0.7% |
| North Coast | 0.6% | 5.3% | 5.3% |
| North Central Coast | 4.2% | 3.9% | 3.9% |
| Northeast Plateau | 5.0% | 2.3% | 2.3% |
| South Coast | 0.5% | 2.4% | 2.4% |
| South Central Coast | 4.1% | 4.6% | 4.6% |
| San Diego County | 1.1% | 2.1% | 2.1% |
| San Francisco Bay | 2.1% | 6.5% | 6.5% |
| San Joaquin Valley | 49.3% | 45.1% | 45.1% |
| Salton Sea | 5.5% | 3.7% | 3.7% |
| Sacramento Valley | 20.0% | 19.3% | 19.3% |
| Total | 100% | 100% | 100% |

8) Utility Trucks

A utility company is defined in the fleet rule for public agencies and utilities as a privately-owned company that provides water, natural gas, and electricity (ARB, 2006b). Some of the large utility companies that operate throughout California register all their trucks at their corporate office making it infeasible to use the actual registration data to allocate utility fleet VMT. However, staff believes most utility trucks are used to service the general population and would have similar allocation as MHDDTs. As a result, staff assumed the same MHDDT spatial allocation in EMFAC 2007 for utility trucks, as shown in Table 24.

Table 24. Regional Allocation for Utility Trucks

| Air Basin | MHDDT Utility | HHDDT Utility | MHDDT EMFAC 2007 | HHDDT EMFAC 2007 |
|---------------------|--------------------------|--------------------------|-----------------------------|-----------------------------|
| Great Basins Valley | 0.1% | 0.1% | 0.1% | 0.6% |
| Lake County | 0.1% | 0.1% | 0.1% | 0.0% |
| Lake Tahoe | 0.1% | 0.1% | 0.1% | 0.1% |
| Mountain Counties | 0.9% | 0.9% | 0.9% | 1.8% |
| Mojave Desert | 2.2% | 2.2% | 2.2% | 15.1% |
| North Coast | 0.7% | 0.7% | 0.7% | 1.4% |
| North Central Coast | 2.6% | 2.6% | 2.6% | 1.8% |
| Northeast Plateau | 0.2% | 0.2% | 0.2% | 1.5% |
| South Coast | 42.5% | 42.5% | 42.5% | 20.0% |
| South Central Coast | 3.5% | 3.5% | 3.5% | 1.3% |
| San Diego County | 7.9% | 7.9% | 7.9% | 3.8% |
| San Francisco Bay | 17.1% | 17.1% | 17.1% | 7.8% |
| San Joaquin Valley | 12.1% | 12.1% | 12.1% | 28.9% |
| Salton Sea | 1.3% | 1.3% | 1.3% | 6.5% |
| Sacramento Valley | 8.7% | 8.7% | 8.7% | 9.6% |
| Total | 100% | 100% | 100% | 100% |

9) Regional Allocation Results

Using the regional allocation described in the previous section, staff estimated the MHDDT and HHDDT VMT for each air basin and calendar year. Table 25 shows the VMT results for selected air basin by fleet category in 2008.

Table 25. VMT by Fleet Category in Selected Air Basins, 2008

| Fleet Category | 2008 Air Basin VMT, Thousand Miles/Day | | | |
|----------------------------|--|-------|-------|------|
| | SCAB | SFBAB | SJVAB | SVAB |
| MHDDT Ag | 7 | 20 | 139 | 59 |
| MHDDT CAIRP | 13 | 5 | 19 | 6 |
| MHDDT instate | 3,577 | 1,878 | 959 | 832 |
| MHDDT instate construction | 530 | 329 | 196 | 115 |
| MHDDT OOS | 8 | 3 | 11 | 4 |
| MHDDT utility | 19 | 9 | 7 | 5 |
| HHDDT Ag | 18 | 49 | 343 | 146 |
| HHDDT CAIRP | 1,341 | 524 | 1,936 | 641 |
| HHDDT CAIRP construction | 102 | 63 | 38 | 22 |
| HHDDT NNOOS | 1,508 | 590 | 2,178 | 721 |
| HHDDT NOOS | 488 | 191 | 705 | 233 |
| HHDDT other port | - | 59 | 37 | 8 |
| HHDDT POAK | - | 205 | 91 | 14 |
| HHDDT POLA | 1,514 | - | 163 | - |
| HHDDT single | 721 | 318 | 178 | 160 |
| HHDDT single construction | 264 | 164 | 98 | 57 |
| HHDDT tractor | 1,891 | 958 | 2,752 | 426 |
| HHDDT tractor construction | 197 | 122 | 73 | 43 |
| HHDDT utility | 11 | 5 | 4 | 3 |

F. Impact of the Recession on VMT and Vehicle Sales

The recession impacts the emissions inventory both in terms of reduced activity and in terms of aging fleets due to reduced new truck sales. Staff developed assumptions for the impact of the recession and future year forecasts for both VMT and vehicle sales by inventory category. These assumptions were fundamentally based on the approach described in previous documentation (ARB, 2008 and ARB, 2009), where staff defined a fast recovery scenario and a slow recovery scenario. The chosen forecast is the average of the two bounding scenarios. This section provides assumptions on activity and new truck sales for each inventory category in graphical format.

To forecast VMT by model year staff followed a multi-step process. To forecast future year VMT, staff multiplied base year VMT by the revised growth factor reflecting the recession for each calendar year for each inventory category. Staff used the methodology described (ARB, 2008 and ARB, 2009) to forecast a model year distribution in each future year based on the assumed sales fraction for each category.

Next, staff multiplied the age-accrual rate schedule by the assumed age distribution in each calendar year for each category to estimate the population-weighted mileage accrual rates for each calendar year and category. To estimate population by model year, staff divided total calendar year VMT by weighted accrual rates in each calendar year.

This approach is a simplification because it assumes the total population in each category will fluctuate with the recession. In reality, to respond to the recession some fleets will downsize or park vehicles, and some fleets will continue to operate most if not all of their vehicles with less mileage accrual per year.

1) Drayage Trucks

Drayage truck activity is developed based on Twenty-foot equivalent unit (TEU) throughput at ports of Los Angeles, Long Beach, and Oakland. Staff estimates that drayage truck VMT in southern California decreased 25 percent between 2006 and 2009 as shown in Figure 10; and in northern California decreased by 14 percent based on container throughput, as shown in Figure 11. The Drayage Truck category was not adjusted for sales during the recession because of the impacts of the Drayage Truck Rule.

Figure 10. Drayage Truck VMT Projection for Ports of Los Angeles and Long Beach and Intermodal Railyards

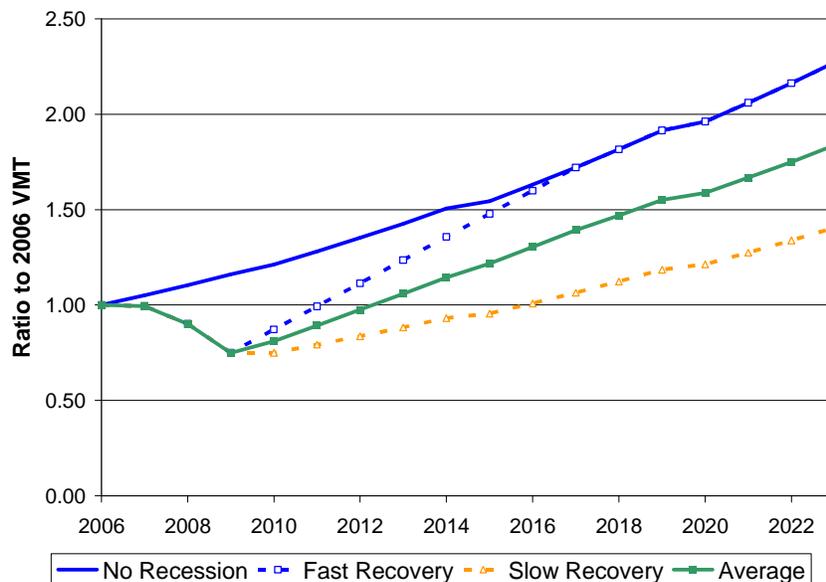
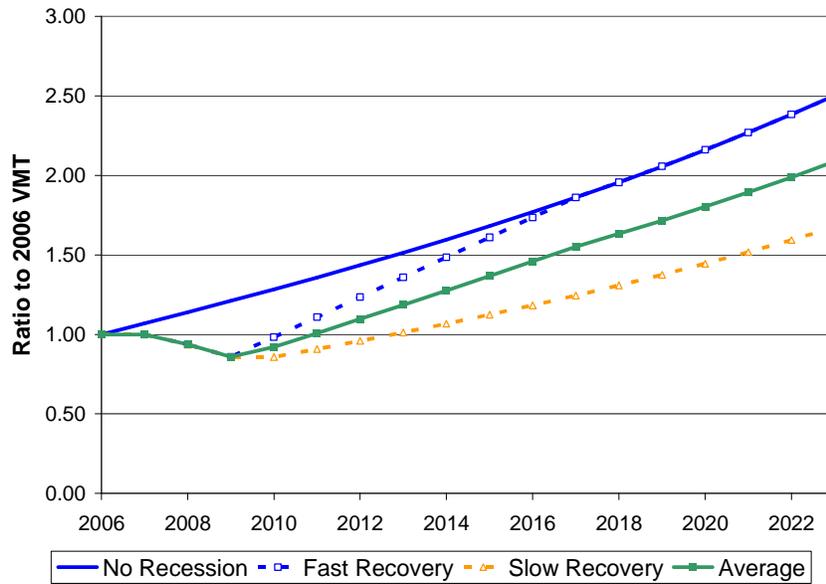


Figure 11. Drayage Truck VMT Projection for the Port of Oakland and Intermodal Railyards



2) Construction Trucks

Assumptions for this category are described in Section C-1.

3) MHDDT

To estimate the impact of recession on MHDDTs, staff reviewed BOE diesel fuel sales data (BOE, 2010b) and estimated VMT growth using bounding scenarios as shown in Figure 12. To forecast MHDDT truck sales, staff used the same method documented (ARB, 2008 and ARB, 2009).

Figure 12. MHDDT VMT Growth Assumption

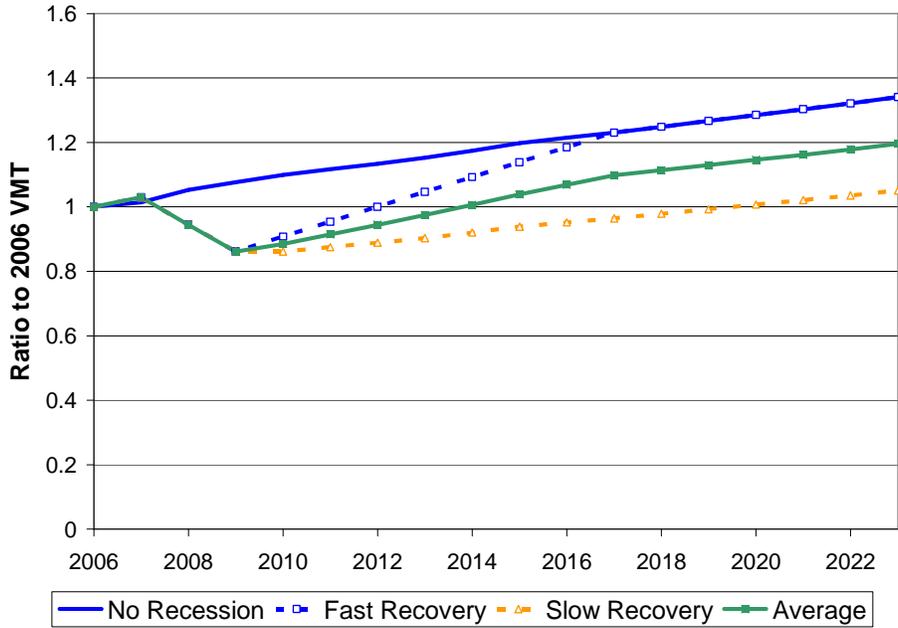
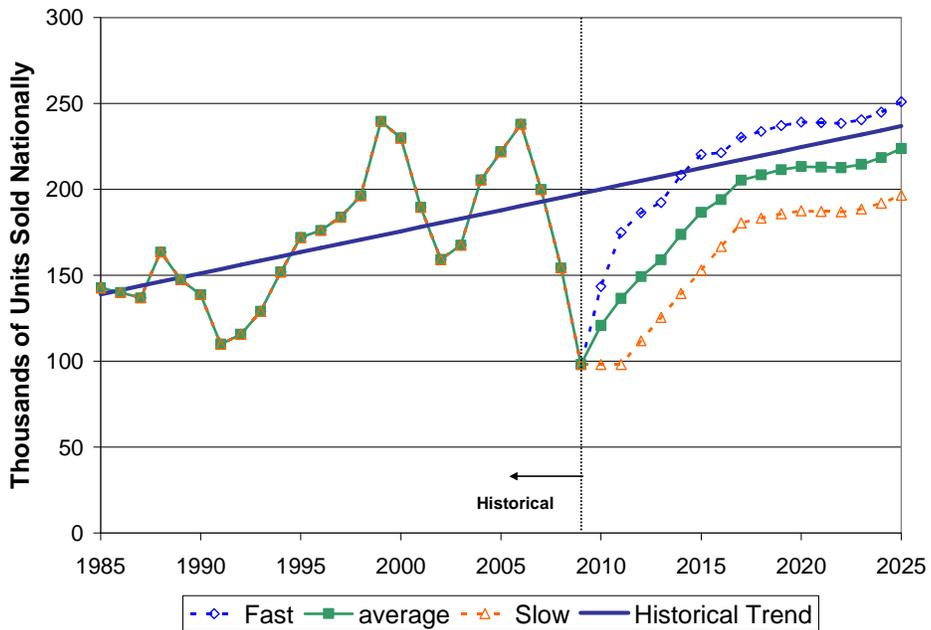


Figure 13. MHDDT Sales Forecast



4) HHDDT

To estimate the impact of recession on HHDDTs, staff reviewed BOE diesel fuel sales data (BOE, 2010b) and estimated VMT growth using bounding scenarios as shown in Figure 14. To forecast HHDDT truck sales, staff used the same method documented (ARB, 2008; ARB, 2009). VMT and sales assumptions apply to all HHDDT categories unless otherwise noted including interstate trucks.

Figure 14. HHDDT VMT Growth Assumption

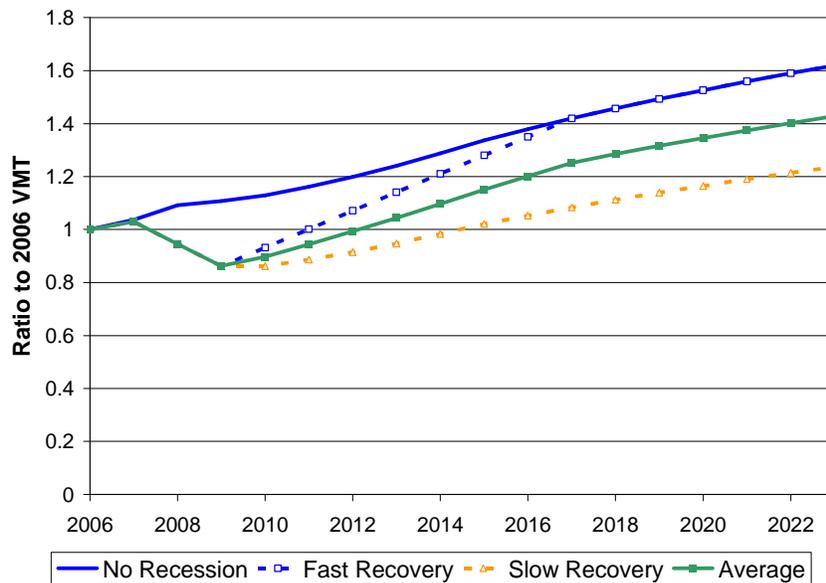
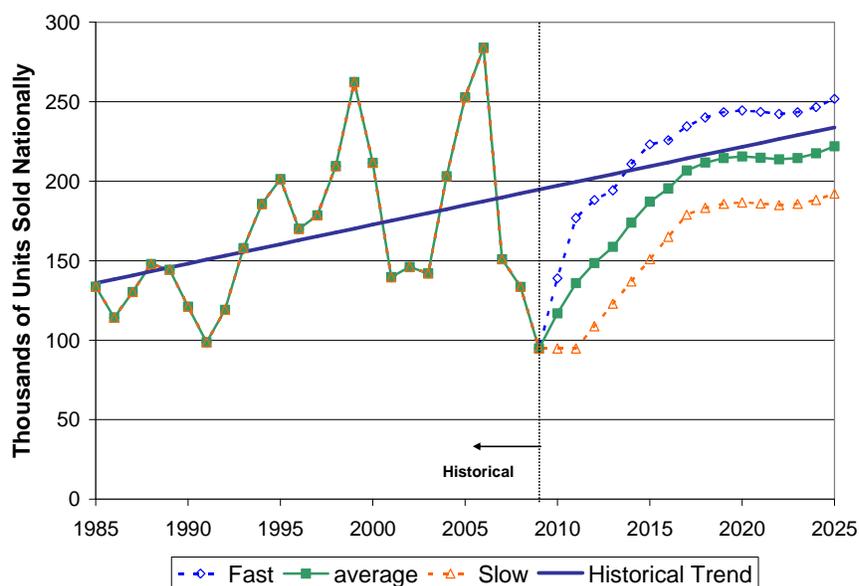


Figure 15. HHDDT Sales Forecast



G. Proposed Regulatory Scenarios and Compliance Assumptions

The proposed regulatory amendments provide substantial economic relief through the focusing of early PM requirements on vehicles that are most cost-effective to control, and on slowing the penetration of NO_x targets over time. To reflect these amendments, staff has made assumptions about how trucks in each category will respond to proposed regulatory requirements. Because of the impact of the recession and the increased life of retrofits before turnover is required in the Rule amendments, staff assumes that all vehicles subject to early PM requirements (2014 and prior) will install a Diesel Particulate Filter (DPF), and that turnover to comply with the regulation will generally occur only when explicitly required.

This section provides the assumptions used to calculate the emissions benefits of the proposed amended regulation for each inventory category for which regulatory requirements changed between the 2008 regulation and the proposed regulation. If the requirements did not change, the assumptions documented in ARB (2008) are still valid. The proposed rule provides specific compliance requirements for MHDDT fleets of truck GVWR of 26,000 lbs or less, regardless of their fleet size. Medium-heavy duty trucks with GVWR above 26,000 lbs are assumed to use the same compliance schedules as heavy-heavy duty trucks depending on their fleet size.

1) MHDDT Rule Compliance (<26,000 lbs GVWR)

This compliance schedule applies to all MHDDT with a GVWR less than 26,000 lbs. It also applies to MHDDT non-specialty agricultural trucks with a GVWR of 26,000 lbs or less and above first mileage threshold as described in ARB (2008).

**Table 26. Turnover Assumptions for Medium Heavy Duty Truck Fleets
GVWR<26,000 lbs**

| By Jan. 1 | Model Year | Turn over to |
|------------------|-------------------|---------------------|
| 2015 | pre-1996 | 2010 |
| 2016 | 1996 | 2011 |
| 2017 | 1997 | 2012 |
| 2018 | 1998 | 2013 |
| 2019 | 1999 | 2014 |
| 2020 | 2000-2002 | 2015 |
| 2021 | 2003-2006 | 2016 |
| 2023 | 2007-2009 | 2017 |

2) Small Fleet Rule Compliance (>26,000 lbs GVWR)

The proposed amendments to the Regulation continue to provide flexibility for small fleets subject to early PM requirements. A small fleet is defined as a fleet that has three trucks or fewer. Staff assumes that small fleets will take advantage of these provisions. Amendments require the first truck in a small fleet to be DPF equipped by 2014, the second truck to be DPF equipped by 2015, and the third truck to be DPF equipped by 2016. Small fleets must then meet Best Available Control Technology (BACT) requirements starting in 2020.

Table 27 presents the revised assumptions for interstate trucks in small fleets, Table 28 presents the revised assumptions for single-unit trucks in small fleets, and Table 29 presents the revised assumptions for tractors in small fleets.

Table 27. Retrofit/Turnover Assumptions for >26,000 lbs GVWR Interstate Trucks in Small Fleets

| Due Date January 1st of Calendar Year | Model Year Group | 1st truck | 2nd truck | 3rd truck |
|---|---------------------|-----------|-----------------------------|-----------|
| 2014 | 2003-2006 | DPF | | |
| 2014 | 1998-2002 | DPF | -- | -- |
| 2015 | 2003-2006 | DPF | DPF | |
| 2015 | 1998-2002 | DPF | 1/3 DPF, 1/3 2008, 1/3 2010 | -- |
| 2015 | Pre-1994 | 2010 | 2010 | -- |
| 2016 | 2003-2006 | DPF | DPF | DPF |
| 2016 | 1998-2002 | DPF | 1/3 DPF, 1/3 2008, 1/3 2010 | 2011 |
| 2016 | Pre-1996 | 2010 | 2010 | 2010 |
| 2017 | 1996-1997 | 2010 | 2010 | 2010 |
| 2020 | 1998-2000 | 2013 | 2013 | -- |
| 2021 | 2001-2004 | 2014 | 2014 | 2014 |
| 2022 | 2005-2006 | 2015 | 2015 | 2015 |
| 2023 | all remaining | 2015 | 2015 | 2015 |

Table 28. Retrofit/Turnover Assumptions for >26,000 lbs GVWR Single-Unit Trucks in Small Fleets

| Due Date January 1st of Calendar Year | Model Year Group | 1st truck | 2nd truck | 3rd truck |
|---|---------------------|-----------|-----------|-----------|
| 2014 | 1998-2006 | DPF | -- | -- |
| 2015 | 1998-2006 | DPF | DPF | -- |
| 2015 | Pre-1994 | 2010 | 2010 | -- |
| 2016 | 1998-2006 | DPF | DPF | DPF |
| 2016 | Pre-1996 | 2010 | 2010 | 2010 |
| 2017 | 1996-1997 | 2010 | 2010 | 2010 |
| 2020 | 1998-2000 | 2013 | 2013 | 2013 |
| 2021 | 2001-2004 | 2014 | 2014 | 2014 |
| 2022 | 2005-2006 | 2015 | 2015 | 2015 |
| 2023 | all remaining | 2015 | 2015 | 2015 |

Table 29. Retrofit/Turnover Assumptions for >26,000 lbs GVWR Tractor Trucks in Small Fleets

| Due Date January 1st of Calendar Year | Model Year Group | 1st truck | 2nd truck | 3rd truck |
|---|---------------------|-----------|-----------------------------|-----------|
| 2014 | 2003-2006 | DPF | | |
| 2014 | 1998-2002 | DPF | -- | -- |
| 2015 | 2003-2006 | DPF | DPF | |
| 2015 | 1998-2002 | DPF | 20% DPF, 60% 2008, 20% 2010 | -- |
| 2015 | Pre-1994 | 2010 | 2010 | -- |
| 2016 | 2003-2006 | DPF | DPF | DPF |
| 2016 | 1998-2002 | DPF | 20% DPF, 60% 2008, 20% 2010 | 2011 |
| 2016 | Pre-1996 | 2010 | 2010 | 2010 |
| 2017 | 1996-1997 | 2010 | 2010 | 2010 |
| 2020 | 1998-2000 | 2013 | 2013 | -- |
| 2021 | 2001-2004 | 2014 | 2014 | 2014 |
| 2022 | 2005-2006 | 2015 | 2015 | 2015 |
| 2023 | all remaining | 2015 | 2015 | 2015 |

3) Large Fleet Rule Compliance (>26,000 lbs GVWR)

The proposed regulatory amendments provide relief to large fleet HHDDTs, because pre-1998 trucks would no longer be subject to early PM requirements. To reflect this change, staff updated compliance assumptions for large fleets. These assumptions are specific to each vehicle category because of differences in average miles traveled and vehicle dollar values between different categories. Table 30 presents compliance assumptions for >26,000 lbs GVWR tractors in large fleets; Table 31 presents compliance assumptions for >26,000 lbs GVWR single-unit trucks in large fleets. The proposed regulatory amendments contain a large fleet provision that allows fleets to install DPFs on 90% instead of 100% of their fleet. To reflect this provision, emissions benefits calculated using Tables 30 and 31 are multiplied by 0.9 to estimate the final benefit from large fleets. This assumption is also discussed in G8 below.

Table 30. Retrofit/Turnover Assumptions for >26,000 lbs GVWR Tractor Trucks in Large Fleets

| Due Date January 1st of Calendar Year | Model Year Group | Assumed Compliance |
|--|---------------------|--------------------|
| 2012 | 1998-2000 | DPF |
| 2013 | 2001-2002 | DPF |
| 2013 | 2003-2004 | DPF |
| 2014 | 2005-2006 | DPF |
| 2015 | Pre-1994 | 2010 |
| 2016 | 1994-1995 | 2011 |
| 2017 | 1996-1997 | 2012 |
| 2020 | 1998-2000 | 2015 |
| 2021 | 2001-2002 | 2016 |
| 2021 | 2003-2004 | 2016 |
| 2022 | 2005-2006 | 2017 |
| 2023 | all remaining | 2017 |

Table 31. Retrofit/Turnover Assumptions for >26,000 lbs GVWR Single-Unit Trucks in Large Fleets

| Due Date January 1st of Calendar Year | Model Year Group | Assumed Compliance |
|--|---------------------|--------------------|
| 2012 | 1998-2000 | DPF |
| 2013 | 2001-2004 | DPF |
| 2014 | 2005-2006 | DPF |
| 2015 | Pre-1994 | 2010 |
| 2016 | 1994-1995 | 2010 |
| 2017 | 1996-1997 | 2010 |
| 2020 | 1998-2000 | 2013 |
| 2021 | 2001-2004 | 2014 |
| 2022 | 2005-2006 | 2015 |
| 2023 | all remaining | 2015 |

4) Agricultural Truck Compliance Assumptions

The proposed regulatory amendments do not alter the fundamental compliance structure for agricultural trucks. However, because of changes to BACT requirements, compliance assumptions for specialty vehicles and some model year groups have been altered slightly, as shown in Table 32.

Table 32. Retrofit/Turnover Assumptions for Agriculture Trucks

Below 10,000 miles/yr and specialty agricultural trucks

| Due Date January 1st of Calendar Year | Model Year | Turnover to |
|---------------------------------------|------------|-------------|
| 2023 | pre-2010 | 2012 |

Above 10,000 miles/yr but below first mileage threshold

| Due Date January 1st of Calendar Year | Model Year | Retrofit /Turnover to |
|---------------------------------------|------------|-----------------------|
| 2017 | pre-1998 | 2010 |
| 2017 | 1998-2006 | 50% 2010 and 50% 2008 |
| 2023 | 2007-2009 | 2012 |

5) Utility Truck Compliance Assumptions

As a result of proposed regulatory amendments, the following assumptions in Table 33 are made for compliance for trucks owned by Utilities.

Table 33. Retrofit/Turnover Assumptions for Utility Trucks

| Due Date January 1st of Calendar Year | T6 Utility | | T7 Utility | |
|---------------------------------------|------------|-----------------------|------------|-----------------------|
| | Model Year | Retrofit /Turnover to | Model Year | Retrofit /Turnover to |
| 2014 | Pre-1998 | 2010 | Pre-1998 | 2010 |
| 2014 | 1998-2006 | DPF | 1998-2006 | DPF |
| 2021 | 1998-2006 | 2013 | 1998-2004 | 2013 |
| 2022 | | | 2005-2006 | 2014 |
| 2023 | 2007-2009 | 2015 | 2007-2009 | 2015 |

6) Drayage Truck Compliance Assumptions

Proposed regulatory amendments would harmonize drayage truck and truck and bus regulatory requirements by removing the Phase II drayage truck requirement to turnover to a 2007 truck by 2014, while keeping Phase I retrofit requirements. Due to requirements imposed by the Ports of Los Angeles and Long Beach, all drayage trucks will meet 2007 standards in 2014; as a result regulatory amendments will have little effect in southern California. Drayage trucks in the Bay Area are not subject to this local requirement, and so benefits of the Drayage Truck Rule will be reduced by these amendments in that area. By 2017, drayage trucks will be required to follow truck and bus requirements, as shown in Table 34.

Table 34. Retrofit/Turnover Assumptions for Drayage Trucks

Assumptions for Southern California Drayage Trucks

| Population distribution | Calendar year | | | | | 2014-2016 |
|-------------------------|---------------|------|------|------|------|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | |
| MY 1994-2003, DPF | 4% | 4% | 4% | 4% | 4% | Trucks new to the drayage service would meet 2007 engine standard |
| MY 2004 | 10% | 10% | 0% | 0% | 0% | |
| MY 2004 DPF | 0% | 0% | 6% | 6% | 6% | |
| MY 2005-2006 | 21% | 21% | 11% | 0% | 0% | |
| MY 2005-2006, DPF | 0% | 0% | 0% | 9% | 9% | |
| MY 2007-2009 | 58% | 58% | 70% | 72% | 72% | |
| MY 2010 and newer | 7% | 7% | 9% | 9% | 9% | |

Approach for Drayage Trucks Outside of Southern California

| Due Date January 1st of Calendar Year | Model Year | Retrofit / Turnover to |
|---------------------------------------|-------------|------------------------|
| 2010 | Pre -1994 | 1994 |
| 2010 | 1994 - 2003 | DPF |
| 2012 | 2004 | DPF |
| 2013 | 2005-2006 | DPF |

Truck and Bus Regulation Assumptions starting in 2017

| Due Date January 1st of Calendar Year | Model Year | Turnover to |
|---------------------------------------|------------|-------------|
| 2020 | pre-1998 | 2010 |
| 2020 | 1998-2000 | 2012 |
| 2021 | 2001-2004 | 2012 |
| 2022 | 2005-2006 | 2012 |
| 2023 | 2007-2009 | 2012 |

7) School Bus Compliance Assumptions

Under the proposed regulation, school bus compliance requirements would be deferred for two years, as shown in Table 35.

Table 35. Retrofit/Turnover Assumptions for School Buses

| Due Date January 1st of Calendar Year | Model Year | Turnover to | Percent with DPF |
|--|-------------------|--------------------|-------------------------|
| 2012 | 1987-2006 | | 33% |
| 2013 | 1987-2006 | | 66% |
| 2014 | 1987-2006 | | 100% |
| 2014 | pre-1987 | 2007 | |

8) Regulatory Credit and Other Provisions - Not Modeled in the Inventory

The proposed regulatory amendments contain several provisions that are not modeled within the inventory, including reduced activity credits, early retrofit credits, alternative fuel credits, and large fleet phase-in. These provisions cannot be explicitly modeled because they are not mandatory, and the choice to exercise these provisions depends on many factors that are difficult to predict. Their impact on the margin is estimated, but other inventory charts shown in Section H do not include the impact of these provisions.

The reduced activity credits and alternative large fleet phase-in relief provisions in the regulation will likely reduce the number of filter equipped trucks, especially in the 2014 timeframe, from what is modeled directly in the inventory. Whether a fleet will choose to exercise reduced activity credits depends on how it has been impacted, and how it has responded to the recession. Some fleets will choose to take advantage of alternative fuel vehicle credits or early retrofits and others will not.

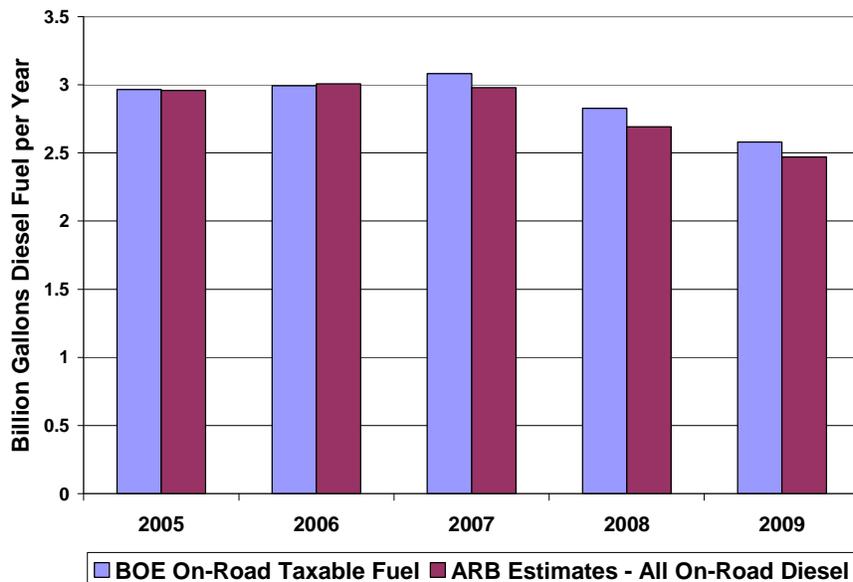
The reduced activity credits are designed to be self-correcting in that if the economy recovers more slowly more credits would be generated, and if the economy recovers more quickly fewer credits would be generated. For example, if the economy recovers more slowly than anticipated, more fleets would use reduced activity credits. This would reduce the benefits the Rule would achieve, but those disbenefits would be offset by reduced activity and emissions caused by the recession.

H. Emissions Results

1) Evaluation of Baseline Statewide Fuel Usage Estimates

The Truck and Bus Rule is not expected to have a significant impact on reducing statewide emissions of CO₂. However, comparing modeled fuel-use in the emissions analysis to the total amount of diesel fuel taxed in California annually is a valuable tool to ensure the emissions analysis is reasonably accurate. To develop this analysis, staff added annual CO₂ emissions estimates for diesel trucks and buses in this inventory to estimates of CO₂ emissions representing light-duty and light heavy-duty diesel vehicles. The combined total represents all on-road use of taxable diesel in California. Staff assumed 10,159 grams of CO₂ emissions per gallon diesel fuel to convert CO₂ emissions to gallons of diesel fuel. Figure 16 compares estimated fuel usage in the inventory analysis (including lighter duty vehicles from EMFAC2007) with on-road taxable diesel fuel provided by the BOE in their 10 year report (BOE, 2010b). Results show very good agreement, within 5 percent or less, between the inventory analysis and reported fuel data.

Figure 16. ARB Modeled Estimates of On-Road Diesel Fuel Use Based on the Emissions Analysis vs. BOE On-Road Taxable Fuel by Calendar Year



2) Estimating Statewide Emissions Benefits of the Proposed Regulation

When the Board adopted the regulation in 2008, the Rule was designed to achieve maximum reduction of diesel particulate matter emissions by 2014, and to ensure maximum NO_x emissions reductions by 2023. The rule was also designed to achieve sufficient NO_x reductions to achieve reductions in nitrate particulate to meet the particulate matter ambient air quality standard in both the South Coast Air Basin and the San Joaquin Valley.

The proposed amendments to the regulation are designed to ensure these overall benefits are achieved at a much lower cost. This is possible because the recession is projected to continue to reduce anticipated emissions levels well into the future. Overall, staff anticipates the amended regulation will reduce diesel PM emissions by 50 percent from currently anticipated levels in 2014, and that the regulation will ensure that by 2020 practically all trucks operating in California will be equipped with a diesel particulate filter. Figure 17 and Figure 18 compare anticipated baseline emissions (without the Rule) to emissions with the amended Rule if it is adopted. Staff anticipates the amended Rule will achieve a 15 percent reduction in NO_x emissions and a 50 percent reduction in PM_{2.5} emissions from anticipated levels without the Rule in place between 2015 and 2023.

The emissions benefits shown in this section cover only BACT requirements and other major portions of the regulation that are modeled in the inventory. Credit provisions discussed in Section G8 of this document are covered quantitatively below in Section H4.

Figure 17. Statewide NO_x Emissions Estimates Baseline and with Regulation

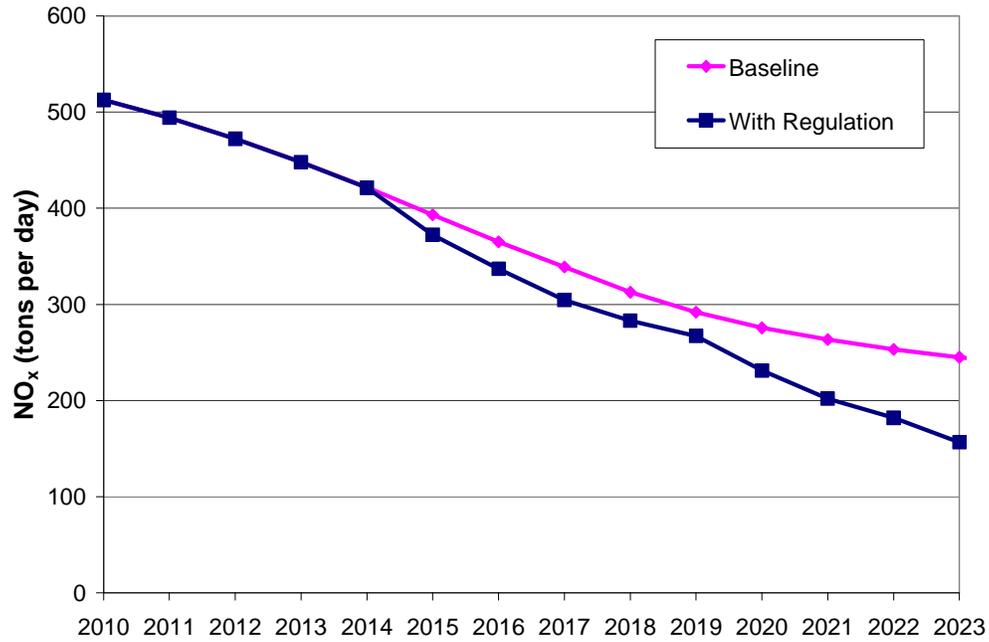


Figure 18. Statewide PM_{2.5} Emissions Estimates Baseline and with Regulation

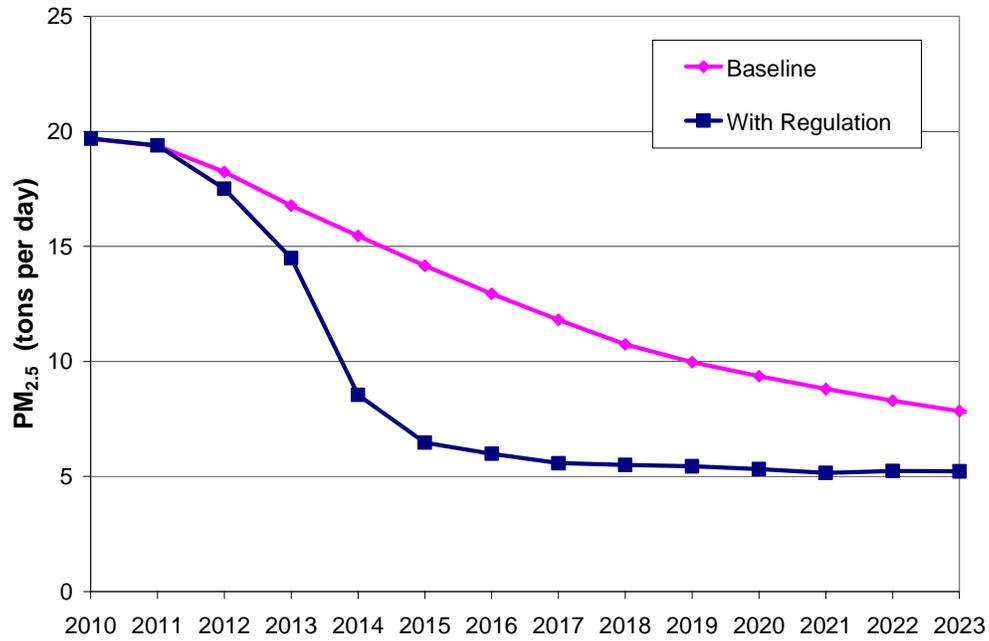


Figure 19 and Figure 20 compare anticipated emissions without the Rule to emissions with the amended Rule in the South Coast.

Figure 19. South Coast NO_x Emissions Estimates Baseline and with Regulation

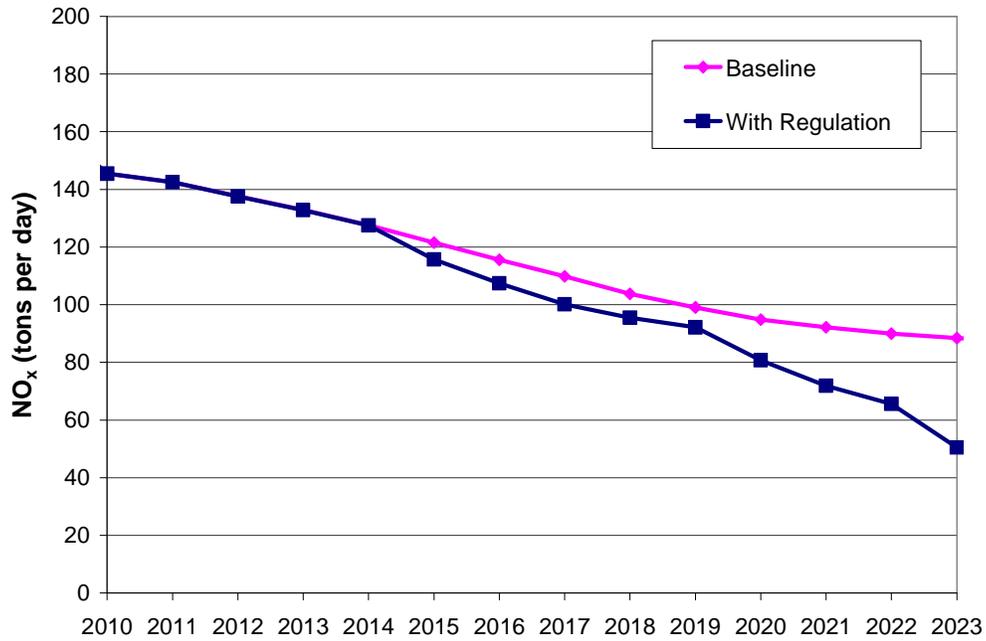


Figure 20. South Coast PM_{2.5} Emissions Estimates Baseline and with Regulation

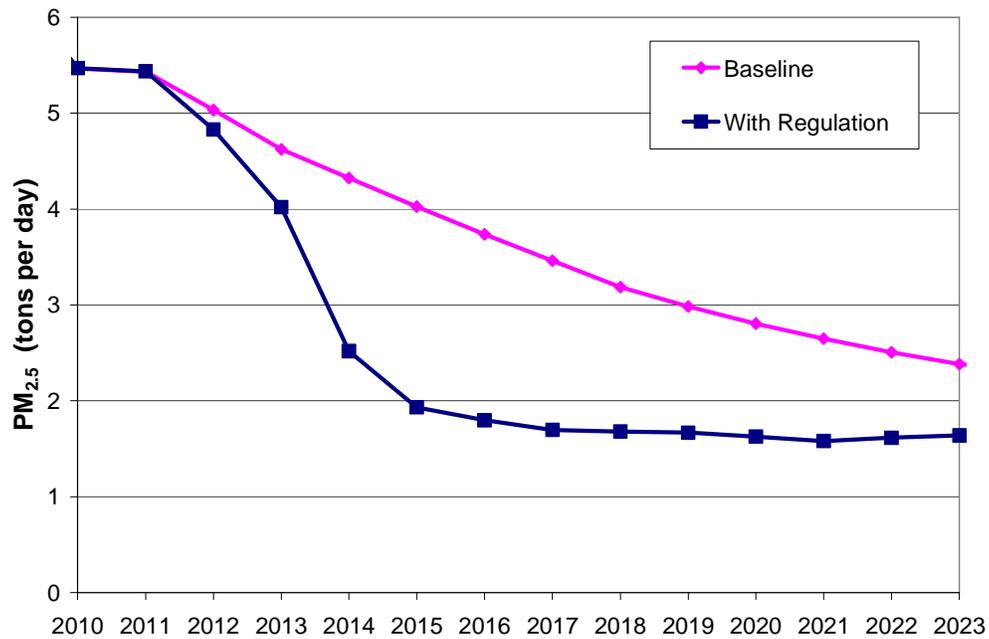


Figure 21 and Figure 22 compare anticipated emissions without the Rule to emissions with the amended Rule in the San Joaquin Valley.

Figure 21. San Joaquin Valley NO_x Emission Estimates Baseline and with Regulation

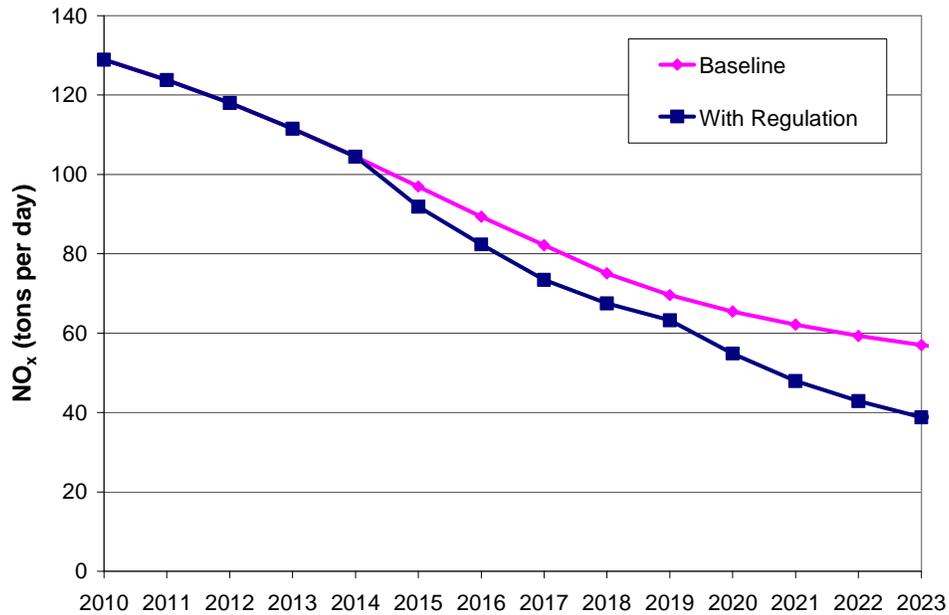
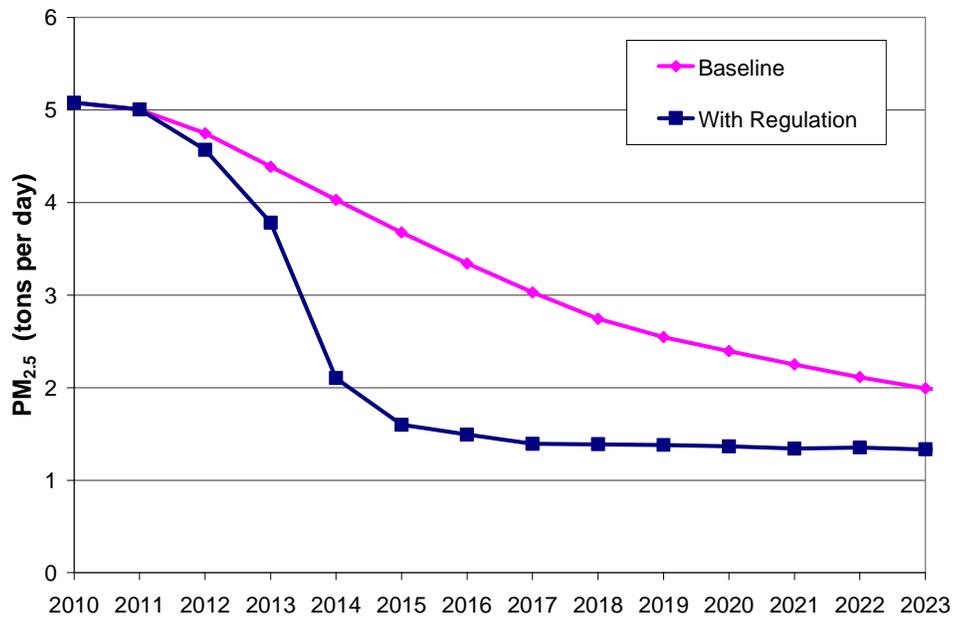


Figure 22. San Joaquin Valley PM_{2.5} Emissions Estimates Baseline and with Regulation



3) PM and NO_x Emissions Benefits from both the Truck and Bus and In-Use Off-Road Rules are Preserved

Staff designed proposed regulatory amendments across both the Statewide Truck and Bus and In-Use Off-Road Rules to provide the maximum amount of economic relief possible while still preserving as much of the originally envisioned benefits as possible. Our estimates suggest that statewide the combined impact of the recession with amended regulations on both on-road and off-road inventories will provide essentially the same cumulative remaining emissions levels between 2011 and 2023 to what the adopted Rules would have achieved without the recession. This concept is shown in Figure 23 for PM_{2.5} and Figure 24 for NO_x below.

Figure 23. Year by Year Comparison of PM_{2.5} Emissions after On-Road and Off-Road Regulations are Applied: Adopted Rules without Recession vs. Amended Rules with Recession

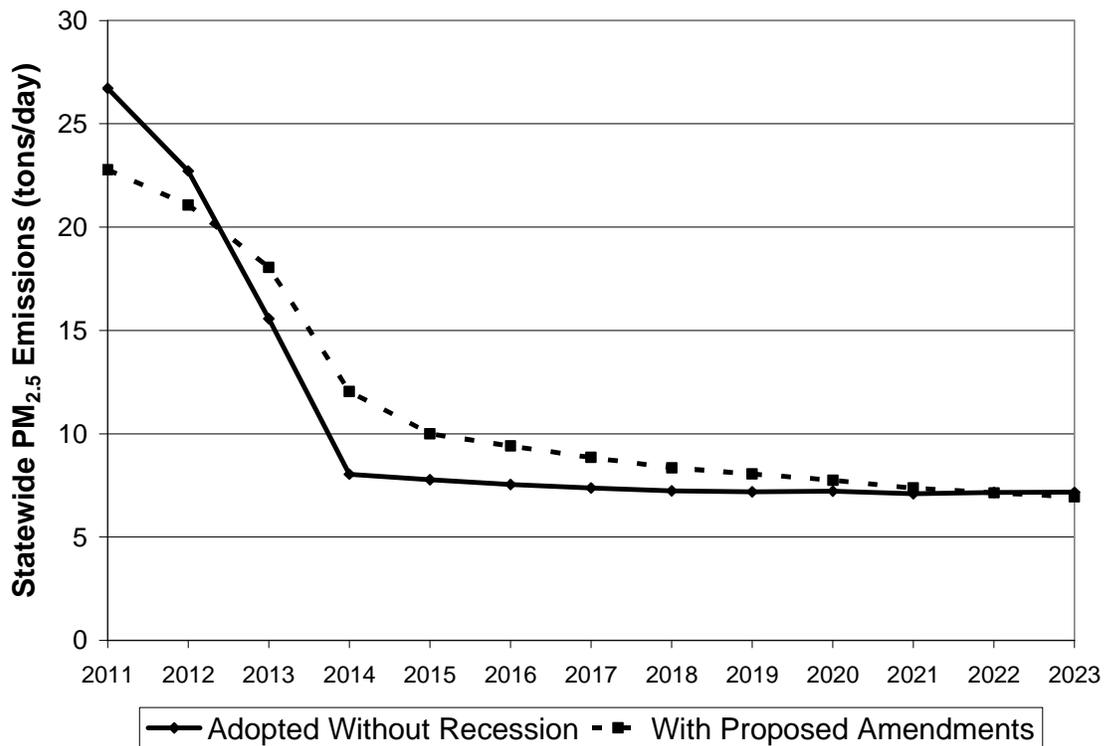
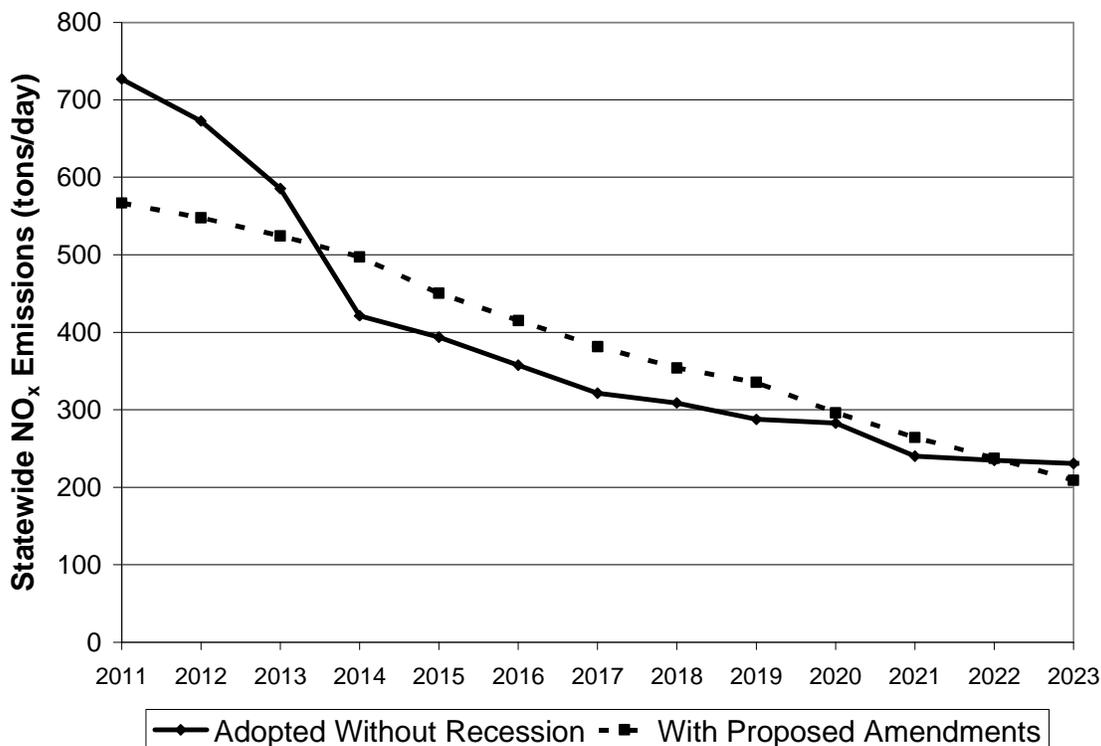


Figure 24. Year by Year Comparison of NO_x Emissions after On-Road and Off-Road Regulations are Applied: Adopted Rules without Recession vs. Amended Rules with Recession



4) Meeting SIP Targets

In September 2007, ARB adopted a State Implementation Plan (SIP) committing the State to develop measures to achieve emission reductions from sources under State regulatory authority. The reductions are needed to attain the Clean Air Act National Ambient Air Quality Standards (NAAQS) for PM_{2.5} in 2014 and for ozone longer term. While multiple areas throughout the State exceed federal air quality standards, the air quality in the South Coast and the San Joaquin Valley poses the greatest challenge and defines the amount of reductions needed. Reductions are needed by 2014 to meet the PM_{2.5} attainment deadline and by 2023 to meet the ozone attainment deadline for compliance with the NAAQS.

Staff decided to consider the impact of the recession and inventory changes on fleets affected by the truck and off-road regulations together in deciding how to provide regulatory relief so that emissions reductions could be targeted more cost effectively, and staff could ensure the combined emissions benefits achieved by the two rules would meet SIP legal requirements for the combined SIP categories.

To develop this comparison, remaining emissions anticipated after the application of the heavy-duty truck and in-use off-road regulatory concepts in the 2007 SIP were compared to anticipated remaining emissions from heavy-duty trucks and in-use off-road equipment in the updated rule inventories. The difference between the remaining emissions in the SIP and in the revised inventory is referred to as the margin. The margin defines how much relief can be provided under the truck and off-road rules while still meeting SIP legal requirements. The margin is compared in NO_x equivalent emissions which is a weighted combination of NO_x and PM_{2.5}. The PM_{2.5} to NO_x ratio is 10:1 in South Coast and 9:1 in the San Joaquin Valley; these numbers were based on photochemical modeling in the 2007 SIP (ARB, 2007b).

Reduced activity credit provisions of the proposed regulatory amendments could not be accurately modeled within the inventory, but are expected to have a significant impact in reducing emissions benefits from strictly what BACT compliance would provide in 2014. This is because under the proposed credit provisions fleets that have downsized as a result of the recession can treat a retired vehicle as compliant, which reduced early PM compliance requirements for other vehicles in the fleet. This effect will be most significant in 2014 when SIP compliance is measured. The large-fleet phase-in requirements could lead to many large fleets meeting early PM requirements for 90 percent instead of 100 percent for vehicles subject to regulatory requirements.

Table 36 compares the 2014 margin in the San Joaquin Valley air basin for several inventory scenarios. The rules as currently adopted would provide a margin of 40 tons NO_x equivalent emissions. After modeling the major portions of the proposed Rule amendments without credit provisions, the remaining margin is estimated at 2.4 tons.

Table 36. Comparison of 2014 Remaining Emissions in the San Joaquin Valley Air Basin After Truck and Off-Road Rules Are Applied: SIP, Adopted Rule, With Rule Inventory (Not Including Credit Provisions)

| San Joaquin Valley | | 2014 NO _x Eq. Emissions (tons/day) | | |
|----------------------------------|-------------------|---|----------|----------|
| | | SIP | Adopted* | Proposed |
| Off-Road | NO _x | 29.1 | 12.1 | 13.4 |
| | PM _{2.5} | 0.7 | 0.4 | 0.6 |
| Trucks | NO _x | 88.6 | 75.2 | 101.8 |
| | PM _{2.5} | 1.9 | 1.1 | 2.0 |
| NO _x Eq (pm*9) | | 141.1 | 101 | 138.7 |
| Margin without Credit Provisions | | | 40 | 2.4 |
| Margin with Credit Provisions | | | n/a | 0 |

* From August 2010 Workshop

Staff estimates that a maximum of 15 percent of the total NO_x equivalent benefits could be lost as a result of the reduced activity credit and large-fleet phase-in requirements of the proposed amended regulation. Staff believes that if the reduced activity credit and large-fleet phase-in requirements of the proposed regulation are considered, the remaining margin would be eliminated. This would represent a reduction in overall benefits of about 14 percent.

Table 37 compares the 2014 margin in the South Coast air basin for several inventory scenarios. The rules as currently adopted would provide a margin of 62 tons NO_x equivalent emissions. After modeling the major portions of the proposed Rule amendments, the remaining margin is estimated to be 7.4 tons. Staff estimates a maximum of 15 percent of the total NO_x equivalent benefits could be lost as a result of the reduced activity credit and large-fleet phase-in requirements of the proposed amended regulation. The total NO_x equivalent benefit in the South Coast in 2014 is 18 tons/day. A 15% benefit loss would be equal to 2.7 tons; a 2.7 ton reduction from the 7.4 margin would leave a margin of 4.6 tons NO_x equivalent emissions after all provisions of the Rule are considered.

Table 37. Comparison of 2014 Remaining Emissions in the South Coast Basin After Truck and Off-Road Rules Are Applied: SIP, Adopted Rule, Provisions Modeled in the Inventory, and All Regulatory Provisions

| | | SIP | Adopted* | Proposed |
|---|-------------------------|-------|----------|----------|
| Off-Road | NO_x | 85.6 | 24.9 | 27.6 |
| | PM_{2.5} | 2.3 | 0.9 | 1.3 |
| Trucks | NO_x | 55.1 | 81.5 | 117.6 |
| | PM_{2.5} | 2.3 | 0.9 | 2.1 |
| NO_x Eq (pm*10) | | 186.7 | 124.4 | 179.3 |
| Margin without Credit Provisions | | | 62 | 7.4 |
| Margin with Credit Provisions | | | n/a | 4.6 |

* From August 2010 Workshop

With the proposed amendments the truck rules will continue to provide major diesel PM emissions reductions to protect public health and to ensure all trucks operating in 2023 are equipped with the cleanest engines available. The combined margin for trucks/buses and off-road equipment is minimized, providing maximum relief while still meeting SIP legal obligations.

I. Additional Documentation

As part of the Rulemaking package staff is providing the emissions inventory model and associated documentation. The following is a guide to the model files and documentation.

There are three folders in the inventory documentation package:

- EI models recession proposed – this folder contains the actual calculations of the emissions inventory for the proposed regulation and with the average of faster and slower growth scenarios
 - Baseline by fleet 10210.mdb – is the starting point of the inventory calculation. Population and VMT by fleet category, model year and air basin are calculated and forecasted. The impacts of Drayage Truck

- regulation and Public and Utility Fleets regulation on drayage trucks and utility fleets are also estimated.
- Base by sub cat 100810.mdb – is where the fleet categories in “Baseline by fleet 100810.mdb” were further divided into sub categories based on fleet size, annual mileage, etc.
 - Modeling assumptions.xls – documents the assumptions for fleet turnover and retrofit under the regulation.
 - XXXAB 102010.mdb – based on the population and VMT in “Base by sub cat 100810.mdb” and the assumptions in “modeling assumptions.xls”, estimates the population and VMT results of fleet turnover and retrofit for each air basin.
 - Combined scenario 102010.mdb – combines the air basin results into one table and calculates the emissions under the proposed rule
- EI models no recession adopted rule – this folder contains the emissions inventory calculations for the adopted regulation without the recession.
 - Baseline by fleet no recession.mdb – is the starting point of the inventory calculation. Population and VMT by fleet category, model year and air basin are calculated and forecasted. The impacts of Drayage Truck regulation and Public and Utility Fleets regulation on drayage trucks and utility fleets are also estimated.
 - Base by sub cat no recession.mdb – is where the fleet categories in “Baseline by fleet no recession.mdb” were further divided into sub categories based on fleet size, annual mileage, etc.
 - XXXAB no recession adopted.mdb – based on the population and VMT in “Base by sub cat no recession.mdb” and the assumptions for the adopted rule, estimates the population and VMT results of fleet turnover and retrofit for each air basin.
 - Combined no recession adopted.mdb – combines the air basin results into one table and calculates emissions estimates with adopted rule and without recession.
 - EI models with recession adopted rule – this folder contains the emissions inventory calculations for the adopted regulation with recession.
 - Baseline by fleet with recession.mdb – is the starting point of the inventory calculation. Population and VMT by fleet category, model year and air basin are calculated and forecasted. The impacts of Drayage Truck regulation and Public and Utility Fleets regulation on drayage trucks and utility fleets are also estimated.
 - Base by sub cat with recession.mdb – is where the fleet categories in “Baseline by fleet with recession.mdb” were further divided into sub categories based on fleet size, annual mileage, etc.
 - XXXAB with recession adopted.mdb – based on the population and VMT in “Base by sub cat with recession.mdb” and the assumptions for the adopted rule, estimates the population and VMT results of fleet turnover and retrofit for each air basin.

- Combined with recession adopted.mdb– combines the air basin results into one table and calculates emissions estimates with adopted rule and without recession.
- Supporting files – this folder contains supporting data/analysis for the inventory
 - Buses – Buses and motorcoach related files
 - Buses population accrual.xls – analysis of DMV data and data provided by CBA to estimate the population and accrual rates for all other buses and motorcoaches.
 - California Public Utilities Commissions.xls - provides the motorcoach population.
 - CBA survey.xls – provide mileage accrual by model year for motorcoaches.
 - EF for bus_PTO.xls – emission factors for buses and PTO.
 - Construction – construction fleets related files
 - BOE Construction Taxable Fuel Refunds.xls
 - Construction allocation pop growth by AB.xls – spatial allocation for construction fleet VMT based on DOF population forecast.
 - Construction Avg age&accrual in VIUS.xls – analysis of age and accrual rate of construction vehicles in VIUS 2002.
 - EDA UCC data analysis.xls – new construction equipment sales financed.
 - Percentage of Construction Trucks.xls – VIUS based analysis on construction population as percentages of HHDDT and MHDDT populations.
 - Emission Factor – emission factor related files
 - NOx adjustment details.xls – calculation to reflect engine manufacturer’s compliance approaches for NOx standard.
 - HHDDT EF NOx adj cap 400_800K.xls – emission factors that reflect both the NO_x adjustment and odometer capping for HHDDT.
 - MHDDT EF NOx adj cap 400_800K.xls – emission factors that reflect both the NO_x adjustment and odometer capping for MHDDT.
 - EF cap 400_800K w NOx rev.xls – combines HH and MHDDT EF files for input to the Access models.
 - Field Study – field study related files
 - Cambridge 2008 trip length.pdf – for estimating the trip length in San Joaquin Valley Air Basin
 - SCAG 1999 trip length.pdf – for estimating the trip length in SCAG
 - Field study folder – documents released in 2010 regarding field study as part of California Public Records Act. Folder contains “Readme.xls” describing the content.
 - Growth & Sales – growth and sales forecasts
 - EIA sales VMT forecast.xls – the 2009 EIA forecast of VMT and new truck sales used for sales forecast
 - Growth w recession.xls – VMT growth trends that reflect recession recovery assumptions

- Sales w recession.xls – Sales forecast reflecting the VMT growth trend with recession
- Misc
 - 2005 T6 GVW split.xls – analysis based on 2005 DMV to estimate the percent of MHDDTs that are above 26,000 lbs GVWR
 - Fuel comparion.xls – based on estimated CO₂ emissions, compare the estimated on-road fuel consumptions to the reported diesel taxable fuel from BOE
 - IFTA 2005~2009.xls - IFTA fuel/VMT from corresponding with BOE
 - Truck NOx_PM contribution to 2010_2020 STWD.xls – contains the analysis of the truck contribution to 2010 statewide mobile source emissions.
- Jan2010 folder – contains files released in 2010 as part of California Public Records Act. README.doc describes the content in the folder.

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K. Attachment – CARB Origin-Destination Survey Questionnaire

CARB HDT Origin-Destination Survey Questionnaire

Survey Location: _____ Direction _____ Date: _____ Time: _____

Surveyor _____

Selection Reason: Random _____ Excess Smoke (_____ %) _____ Other: _____

Truck Information

1. Vehicle Type (circle one): Single Unit w/ trailer Tractor-Trailer (Trailer is 53' or longer? Y / N)
Multiple-Trailer Tractor Dump truck Concrete mixer

If a tractor-trailer, does the owner of the tractor also own the trailer? Yes ___ No ___ Don't Know ___

2. Number of axles: Tractor _____, Trailer _____, Total: _____
3. Where is the home base of this vehicle? City _____ State _____
6. License Plates: US State _____ Number _____
Mexico _____ Canada _____

7. Make and Model Year of truck: _____

8. Make and Model Year of engine: _____

10. Has the engine been rebuilt or replaced?(circle one) Yes No Unknown

13. Odometer: _____

14. What is the current loaded weight of this truck? _____ lb

15. What is the Gross Vehicle Weight Rating (GVWR or GCWR) of this truck? _____ lb

Fueling Information

16. Total Fuel capacity of this truck: _____ gallons

17. Where did you last fuel up this truck? City _____ State _____

18. Where will you next fuel up this truck? City _____ State _____

19. Where do you usually buy fuel? CA Mexico Canada Other US State (specify): _____

Activity Information

20a. Where did your current trip begin? City _____ State _____ Country _____
Address _____

21. What is the destination of your current trip?
City _____ State _____ Country _____
Address _____

21a. How many tractors/trailers are there in your company? (OK if estimate) Tractors _____/Trailers _____

Maintenance Information

34. In the past 12 months, has your truck had any downtime for repairs due to problems with the truck engine? Yes ___ No ___ Unknown ___

35. During the past 12 months, which of the following malfunctions have you had on your truck?

(Check all that apply):

Fuel Injection Problems: Mild _____ Medium _____ Severe _____

Engine Failure _____

Electronic Failure _____

Turbocharger Problems _____

Intercooler Problems _____

EGR Problems _____

Air/Fuel Ratio Control _____

Clogged Air Filter _____

Other Air Induction Problems _____

Excessive Engine Oil Consumption _____

PM Filter (DPF) Problems (if equipped) _____

Other _____

PrePass Program (skip this if survey conducted at weigh stations)

36. Is this truck currently enrolled in the Caltrans PrePass™ program? Yes ___ No ___ Unknown ___

Comments: _____

Contact: Zhen Dai, CARB PTSD Mobile Source Analysis Branch (916) 322-7455 or zdai@arb.ca.gov

